POWER

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Depreciation

TO THE power-plant engineer who would like to keep a record of the cost of running his department, the item of depreciation has caused more confusion and discouragement than any other.

He can keep an account of the money that he sees spent from week to week and from month to month for coal and labor and repairs, etc.; he can divide the total of such items by his output in kilowatt-hours or horsepower-hours or barrels of flour or other product and find the apparent cost per unit of output, but he is at a loss to understand this intangible thing that they call depreciation.

Suppose that instead of buying his coal by the load, he bought a year's supply at a time. He would not charge the cost of all that coal to the month in which it was paid for. If he knew that it was a twelve-months' supply and that the consumption ran about even, and he had no means of determining just how much he used each month, he could charge each month with one-twelfth of the total sum paid.

Suppose he buys an engine for $20,000. He cannot charge that whole sum to the first month's run or the first year's run, so he estimates that the engine will last about twenty years, and each year he charges into the cost of running his plant $1,000 worth of engine.

He has used up during the first year, if his guess is right, in addition to coal and water and oil and other supplies that were bought as he used them, $1,000 worth of the twenty-years' supply of engine that he bought all at once.

His guess may be long or short. If it is too long, his account will be short of the real cost of power for the years during which the engine proves serviceable, but succeeding years, after the engine has been scrapped, will have to carry the amount that has not been written off as depreciation in addition to the sum paid for the engine that replaces it. If his estimate is too short, his power will apparently cost him more than it really does during the years of depreciation, but at the end of that time he will have some years when the power will apparently be cheaper than it really is, for he will not have to charge anything at all for engine.

If one could know that his business was going to last long enough to wear an engine out and just how many horsepower- or kilowatt-hours it would turn out while it lasted, he could figure the cost of engine per horsepower-hour just as he does the cost of coal per horsepower-hour, and the problem would be easy. Since he cannot know this, the best that he can do is to make the most intelligent estimate possible.

The man who is trying to keep the apparent cost of his power down will be inclined to the long estimate. The man who is trying to show that the cost of making power is high will lean toward the shorter term and the larger percentage of depreciation.

The best way is to make the estimate that is most probably right and not fool yourself or try to fool anybody else.

F. R. Low

Power Plant of the Provincial Hospital, Weyburn, Sask., Canada

Plant About Thirty Miles from Lignite Coal Fields—Burns This Fuel on Chain-Grate Stokers Under Water-Tube Boiler—Main Units, Vertical High Speed Engines with Direct-Connected Generator and Exciter

SITUATED in the outskirts of Weyburn, and close to the Souris River, is the new Provincial Mental Hospital of the Province of Saskatchewan. The building is in the shape of the letter X with the administration offices in the center, and is constructed of Tee-Pee-Moka brick and Tyndall stone with steel frame and is fireproof throughout. Suitably located and adjacent to the hospital is a modern power plant supplying the institution with light, heat, power and other services.

A general view of the engine room is shown in Fig. 1. The generating equipment consists of one high-speed compound engine, size 9x15x9 in. direct connected to a 125-kva. alternating-current generator and two 13x20x9 in. engines of the same type direct connected to 183-kva. three-phase 60-cycle 2,300-volt generators and operating at 450 r.p.m. An exciter of suitable capacity and of the compound-wound interpole type is mounted on each generator shaft outside the outboard bearing. The units operate on a steam pressure of 130 lb. and are non-condensing.

The engines, which are of the vertical two-cylinder compound type, are equipped with an uncommon type of valve gear; governing is effected by the control of the throttle valve and by means of an expansion gear which is fitted to the high-pressure cylinder. A centrifugal governor is fixed on the end of the crankshaft and is directly connected to the throttle valve through a bell crank lever. In addition the governor is connected to the automatic expansion gear through a second arm of the bell-crank lever. The expansion gear varies the cutoff in the high-pressure cylinder from approximately 40 to 85 per cent of the stroke according to the load on the engine. The alteration in cutoff is effected by slightly rotating the high-pressure valve, which has angular ports and works across corresponding angular ports in the valve-chest liner. By means of this rotation the lead of the valve and the cutoff are varied.

The main lighting and control board is shown at the left of Fig. 1 and consists of ten panels of black marine oiled slate and is equipped with the usual overload and reverse current-relays, indicating and recording meters.

Details of the Boiler Plant

The boiler plant consists of four 2,500-sq.ft. water-tube boilers of the inclined-tube type. There are two drums 36 in. in diameter and 24 ft. in length. The

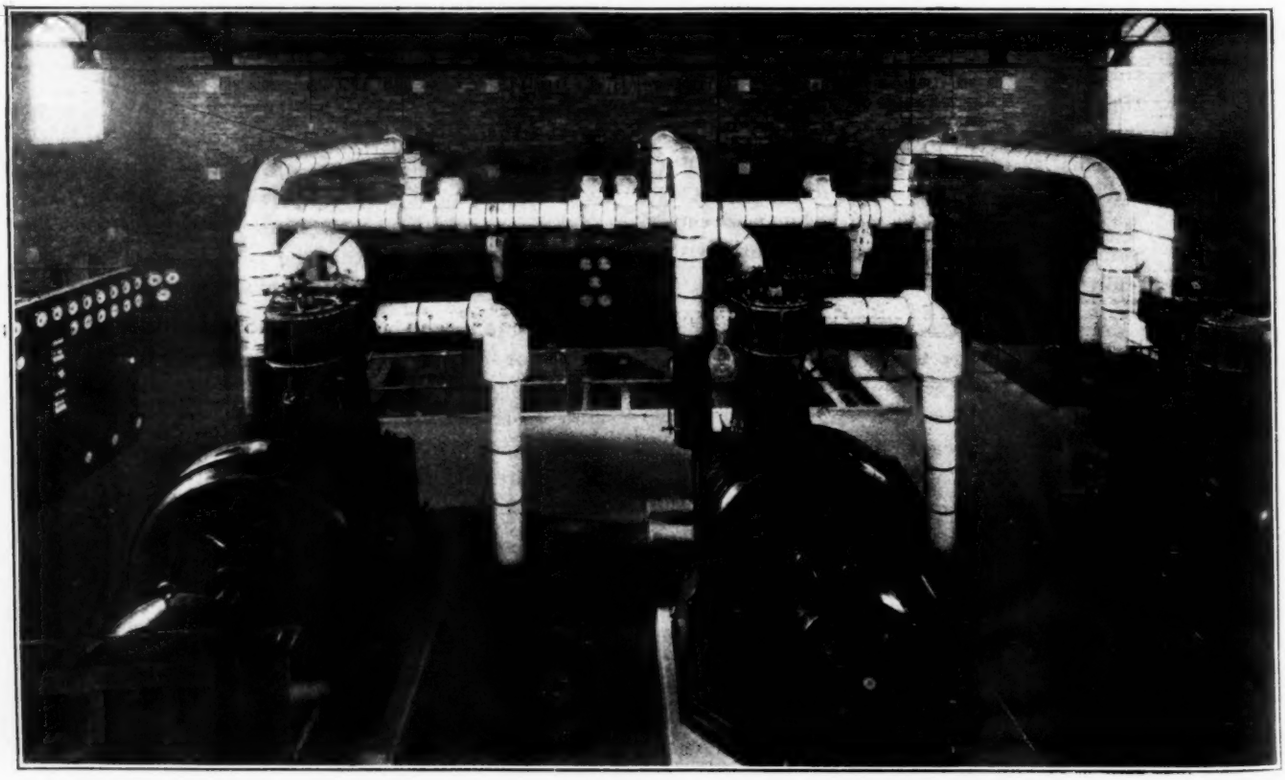


FIG. 1—VIEW OF ENGINE ROOM, SHOWING GENERATING UNITS WITH TOTAL CAPACITY OF 500 KVA.

shell is of ½-in. plate with a butt and double-strap joint, double-riveted and heads of ⅝-in. plate. There are 108 four-inch tubes 18 ft. in length. Each boiler is fitted with four 3-in. pop safety valves and mechanical soot blowers. The boilers are fired by chain-grate stokers with an active grate area of 55 sq.ft., giving a ratio of heating surface to grate area of 45 to 1. The stokers are driven by a 5-hp. 230-volt alternating-current motor operating at 900 r.p.m. and belted to the eccentric shaft that is carried along the front of the boilers above the coal-feeding hopper. The drives of the eccentric are in turn connected to the control lever of the stokers, within easy reach of the fireman. As the plant is about thirty miles from the lignite coal fields in the south of the province, this coal is being used as fuel.

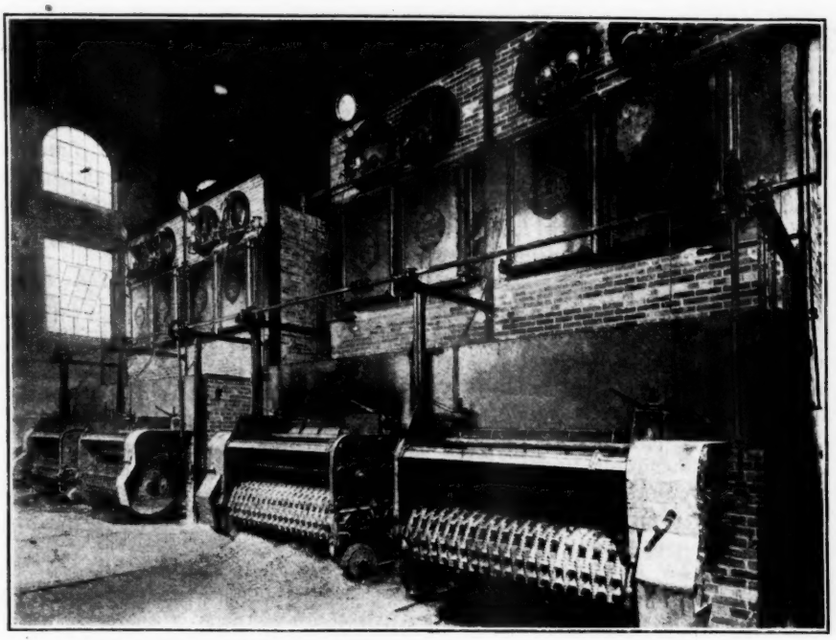


FIG. 2—FRONT VIEW OF BOILERS AND CHAIN-GRATE STOKERS

Induced draft is supplied by two multi-blade fans with water-cooled pedestal-type bearings. These fans have a normal capacity of 27,000 cu.ft. of air per minute at a temperature of 550 deg. F. and give a draft above the fire of 1 in. of water. Each fan is direct-connected to a 15-hp. marine-type vertical engine, the speed of which is controlled by a damper regulator.

The coal as received is dumped directly into the bunker through cover traps. A scale is provided for weighing the coal as fired, this being done while loaded in industrial cars and from which it is shoveled to the stoker hoppers. The ash and refuse carried over at the rear of the grate drop down into the ash tunnel and are removed by a single-strand chain conveyor driven by a 3-hp. motor. The blowoff connections from the mud drum are brought out through the boiler setting with a long-radius bend and have two valves, as shown in Fig. 3. The main blowoff line is 6 in. in diameter and discharges into a 36 x 96-in. settling tank. The main steam outlet from each boiler is fitted with an angle-type automatic non-return valve, and from this the branch connects through a gate valve of the outside screw and yoke type to a common 10-in. header from which the steam is taken for the generating units and is then carried down to the basement for distribution to the different auxiliaries. The layout of the piping in the engine room is clearly shown in Fig. 1. Long-sweep bends have been used wherever practical, and all high-pressure piping has rolled-steel Vanstone joints.

The exhaust steam from the generating units and auxiliaries passes to the heater and to the main heating header. Live steam is also admitted to this header under control of one high-pressure and one low-pressure reducing valve, the pressure in the main being variable from atmosphere to 2 lb. gage.

The feed-pump installation consists of two 7½x4½x10-in. duplex pumps of the outside packed plunger type. These are installed close to the heater in the basement below the engine room. The feed-water piping is of

DATA ON THE PRINCIPAL EQUIPMENT IN THE POWER PLANT OF THE PROVINCIAL HOSPITAL, WEYBURN, SASKATCHEWAN

BOILERS

Manufacturer	Goldie-McCulloch Co.
Type	Water-tube
Number installed	4
Water-heating surface per boiler, sq.ft.	2,500
Size of tubes, in. diameter	4
Number of tubes	108
Boiler designed pressure, lb. gage	175
Boiler operating pressure, lb. gage	130

STOKERS

Manufacturer	Laclede Christy Clay Products Co.
Type	Chain grate
Grate surface, sq.ft.	55
Drive	5 hp. 230 volt motor
Draft	Induced
Draft equipment	Sheldon's, Ltd.
Type	Multi-vane
Number	2
Capacity, cu.ft. per min., 1 in. water, 550 deg.	27,000
Drive	15 hp. vertical engine

PRIME MOVERS

Manufacturer	Goldie-McCulloch Co.
Type	Two-cylinder compound non-condensing
Number installed	3
Capacity, each	One 125 kva. two 188 kva., 450 r.p.m.
Type generator	Alternating current, 3 phase, 60 cycle, 2,300 volt
Manufacturer	Canadian Westinghouse Co.

MISCELLANEOUS EQUIPMENT

No.	Equipment	Type	Size	Manufacturer
2	Feed pumps	Duplex	7½x4½x10 in.	Fairbanks-Morse Co.
2	Fire Pumps	Duplex	10x12x6 in.	Fairbanks-Morse Co.
1	Service pump	Duplex	10x12x6 in.	Fairbanks-Morse Co.
2	Circulating pumps	Centrifugal	(Hot water service)	Canadian Westinghouse Co.
3	Vacuum pumps	Duplex	8x12x16	Darling Bros.
2	Sump pumps	Vertical Centrifugal		Yeoman Bros.
2	Air compressors	Steam driven	11x11x12 in.	Westinghouse
1	Heater	Open	10,000 lb. per hour	Darling Bros.
3	Heaters (Hot-water service)	Removable coil		Patterson-Kelley Co.
1	Conveyor (ash)	Single chain bucket, (motor-driven)		Jeffery Conveyor Co.
	Heat regulators			Powers-Regulator Co.
	Pump governor—Service pumps			Fisher Governor Co.
	Pump governor—Vacuum pumps			Darling Bros.
	Soot blowers—Vulcan 6-unit			Vulcan Soot Cleaning Co.
	Valves (soot blowers)			Homestead Valve Mfg. Co
	Reducing valves			Fisher-Governor Co.
	Non-return valves			Lunkenheimer Co.
	Globe and angle valves			Lunkenheimer Co.

heavy brass throughout and connects to the boiler at the front head. Adjacent to the feed pumps are two 10x6x12-in. duplex pumps automatically controlled and connected to the regular city water supply and used for booster and fire service.

Since in an institution of this kind an abundant supply of soft water is necessary for laundry and other purposes, an additional 10x6x12-in. duplex pump is provided and takes its supply from the Souris River, the water passing through a filtering and softening process.

Hot Water Supplied by Removable Type Coil Heater, Under Thermostatic Control

To provide an adequate supply of hot water, three 48x120-in. horizontal heaters are installed. These are fitted with removable-type heating coils made up of 300 lin.ft. of seamless drawn copper tubing and connected to the low-pressure steam supply under thermostatic control. The water is circulated through the system by two motor-driven rotary pumps and the necessary recording instruments are provided.

All condensation from the heating system is taken care of by three 8x12x16-in. vacuum pumps automatically controlled and discharging to a 30x84-in. receiver located about 25 ft. above the heater and vented to the atmosphere. From this receiver the water flows by gravity to an open heater of 30,000 lb. capacity. The condensation in the high-pressure steam mains and separators is discharged through two high-pressure traps directly to the heater.

Air for cleaning and other purposes around the plant is supplied by two 11x11x12-in. steam-driven compressors discharging directly to an 18x48-in. receiver from which an air line is carried to the boiler front for operating tube-cleaning hammer and to the engine room

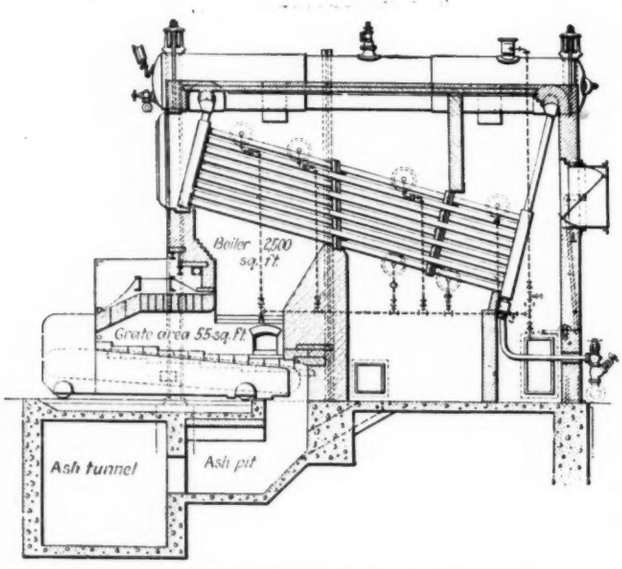


FIG. 3—CROSS-SECTION OF FURNACE AND BOILER SETTING

for cleaning generators, etc. Compressed air for the heat-regulating system used throughout the building is supplied by two 4x3x6-in. compressors automatically controlled.

All drains in the plant are led to a common pit from which the water is discharged by two float-controlled motor-driven centrifugal pumps into the city sewage system. All steam and hot-water pipes, as well as other parts of equipment, are well insulated, and all piping is arranged with a view to accessibility for the operation of valves and maintenance.

The design and construction of the building were carried on under the direction of M. W. Sharon, provincial architect, and the plant is operated under the direction of the mechanical superintendent, G. V. Reed.

Cutting Wire Rope

By Charles A. Armstrong

If wire rope is to be maintained at its original efficiency it is essential that care be used in handling it when being installed. In the manufacturing process great care is exercised to maintain an even tension in the wires and strands of which the rope is composed. If it is allowed to untwist or all strands are not held equally firm in the sockets or other attachment devices,

BOLT CUTTERS USED TO CUT WIRE ROPE

the uniformity of the rope will be disturbed and its useful life impaired. When cutting wire ropes, it is necessary to seize the rope properly with small iron wire before cutting. If the rope is being cut in two, it must be seized on each side of the cut. In best practice it is recommended that three sets of seizing be used on each side of the cut. It is not much use to put more than about ten wraps per seizing unless a serving mallet be used.

The size of wire used in the seizing is of importance, and Roeblings advocate the following sizes of annealed iron wire.

Diameter of Rope, in Inches	Diameter of Seizing Wire, in Inches
$\frac{5}{16}$ to $\frac{1}{2}$ (inclusive)	0.047
$\frac{9}{16}$	0.054
$\frac{5}{8}$ to $\frac{3}{4}$	0.063
$\frac{7}{8}$ to $1\frac{1}{4}$ (inclusive)	0.080
$1\frac{3}{8}$ to $1\frac{7}{8}$ (inclusive)	0.105
2 and larger	0.135

For cutting the rope, a hacksaw may be used to good advantage. A hammer and cold chisel are frequently used, but are not to be recommended, since from the way the cable is generally handled during the operation, it is liable to be distorted and its uniformity disturbed. Bolt cutters, as shown in the figure have proved to be effective and do a neat, quick job. In fact, where single strands of cable are being cut, they are superior to any other device.

When it is desired to collect condensate from low steam-pressure apparatus, heating coils, etc., that are located several stories above the ground level, a very effective automatic trap may be made of a U-tube consisting of the condensate discharge lines brought down to the ground floor and then connecting into a manifold. The outlet from this manifold is then led back up to a height somewhat greater than the head corresponding to the steam pressure used, when a vacuum break is installed, then piped to hotwell or heater.

A good pipe joint cement that can be used on pipe lines carrying steam, water or air, may be made by mixing equal parts of Portland cement and boiled oil. This mixture should be stirred while being used.

How Powdered Coal Is Burned at Lakeside

Details of Conveyor System, Burners and System of Regulation—Operating Problems Encountered and How They Have Been Met

MUCH has been published and said about the use of powdered coal at the Lakeside Station of the Milwaukee Electric Railway & Light Co.[1] Perhaps this is the best reason that there should be still another article to satisfy the curiosity that has been awakened as to the method of handling this kind of fuel and the details of the apparatus in which it is burned.

A cross-section of the boiler and furnace is shown in Fig. 2. Each boiler, of which there are eight already installed, has

Evaporating surface (boiler)	13,060 sq.ft.
Evaporating surface (water screen)	286 sq.ft.
Total evaporating surface	13,346 sq.ft.
Superheating surface	4,023 sq.ft.
Economizer surface	7,603 sq.ft.
Ratio superheating to evaporating surface	0.301
Ratio economizer to evaporating surface	0.569
Rated capacity at 3 lb. per hr. per sq.ft. evaporating surface	40,230 lb.
*Maximum attained capacity, per cent of rating	250
Maximum attained capacity, lb. per hr. evaporated	100,219
Number of burners per boiler	6
Normal rate of coal feed per burner	1,467 lb.
Maximum rate of coal feed per burner	1,903 lb.
Effective combustion space	6,073 cu.ft.
Coal burned per hr. per cu.ft. of comb. space (normal)	1.45 lb.
Coal burned per hr. per cu.ft. of comb. space (maximum)	1.88 lb.

*The maximum attainable capacity is limited, not by the capabilities of the furnaces and the fuel-burning processes, but by the ability of the induced draft fans to remove the products of combustion and the fact that there is a 0.3-in. drop through the superheaters.

The coal, which is pulverized in a separate building until some 60 per cent will pass through a 200-mesh sieve, is delivered to bins, one of which is in front of and above each boiler, as shown in Fig. 2. This is a cross-section of one of the boilers especially fitted for research work and testing, with coal- and water-weighing tanks, gas-sampling tubes, pyrometers, thermocouples, etc. For determining the performance of the station as a whole all the coal is weighed into the bunkers and all the feed-water is measured in a V-notch meter. Steam-flow meters are attached to the outlets of the boilers, of which each boiler has two.

For other than the test boiler the coal, instead of being delivered to the coal-weighing tanks, is carried directly to the bins through the closed tops, so that no dust escapes into the room. It is brought from the pulverizing house by a Fuller-Kinyon pump, a section of which is shown in Fig. 1.

This pump conveyor system consists of a barrel *A* containing a direct-driven worm or screw *B*, a hopper *C*, an air compressor *D* with tank *E*, and the conveyor pipe line *P*. The pulverized coal is fed into the hopper, whence it is discharged by the screw into the pipe line. At the point of discharge a number of small streams of compressed air are admitted. These aërate the mass of powdered coal, creating a semi-fluid condition sufficient to cause it to flow readily through the pipe line.

The bins are rectangular in plan, 30 ft. long by 8½ ft. wide, of steel plate, and have a capacity of 105,000 lb. each. They are lined with concrete, as much because the coal flows better over the concrete surface as for preserving the metal. There has never been any tendency observed at Lakeside for the coal to ignite spontaneously or even to heat unduly in the bins.

[1] See *Power*, April 18, 1922.

To the hopper-shaped bottom of each bin are attached three duplex feeders, one of which is shown in section in Fig. 3. The shaft *A* is driven at 279 r.p.m. by a 3-hp. constant-speed motor, and its power is transmitted through the Reeves variable-speed transmission *B* and the chain belt *C* to the shaft *D*, which is connected by another chain belt to the shaft *E*. Upon the shafts *D* and *E* are screw conveyors *F*, either or both of which may be put into or out of operation by the clutches *G*. A gate *H* shuts off the coal supply in case access to the burner is required, and a handhole is provided at *I*.

At the bottom of the feeder and extended to surround its delivery tubes is an air box *J* into which air is forced under a pressure of about 10 in. of water by a motor-driven steel-plate blower. The air main and connection are shown in Fig. 2. About 1½ lb. of air per pound of coal fed, which is about 15 per cent of the air needed for combustion, is admitted at this point, and from 2.5 to 3 kw.-hr. is required for this purpose per ton of coal fed. This is the only air required under pressure.

The screw conveyor, running at a speed of from 30 to 150 r.p.m., delivers the coal at the point where this air discharges through an annular opening, and the coal is taken up by the air current and, suspended in it, is carried to the burners. *K* is a paddle to facilitate the proper mixing of air and coal before discharge to burner.

There are two of these feed screws to a feeder and three feeders to each bin, making one feed screw for each of the six burners used to a boiler. The ratio of

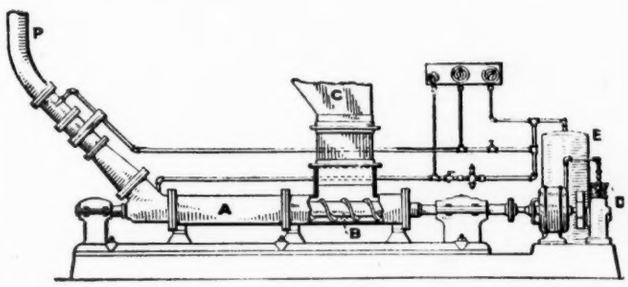


FIG. 1—FULLER-KINYON PUMP

the Reeves transmission is 5 to 1, so that by the use of the clutches *G* any or all of the six burners may be put into operation and their rate of feed varied in the ratio of 1 to 5, giving a control of the amount of coal fired per boiler of from 1 to 30.

The burner, as shown in Fig. 4, consists of a flattened or fantail nozzle having a width at its delivery end of 16 in. and an internal thickness of ⅝ in. The coal-laden stream of air under pressure enters at the top and is delivered to the furnace in a thin sheet. A slight vacuum, from 0.05 to 0.20 of an inch of water, is maintained in the furnace so that air is drawn in at the main air inlet at the right, 20 to 25 per cent of that required entering at this point. The gate by which this opening is regulated is operated by the main adjustment *B*. The auxiliary adjustments *C* and *D* operate

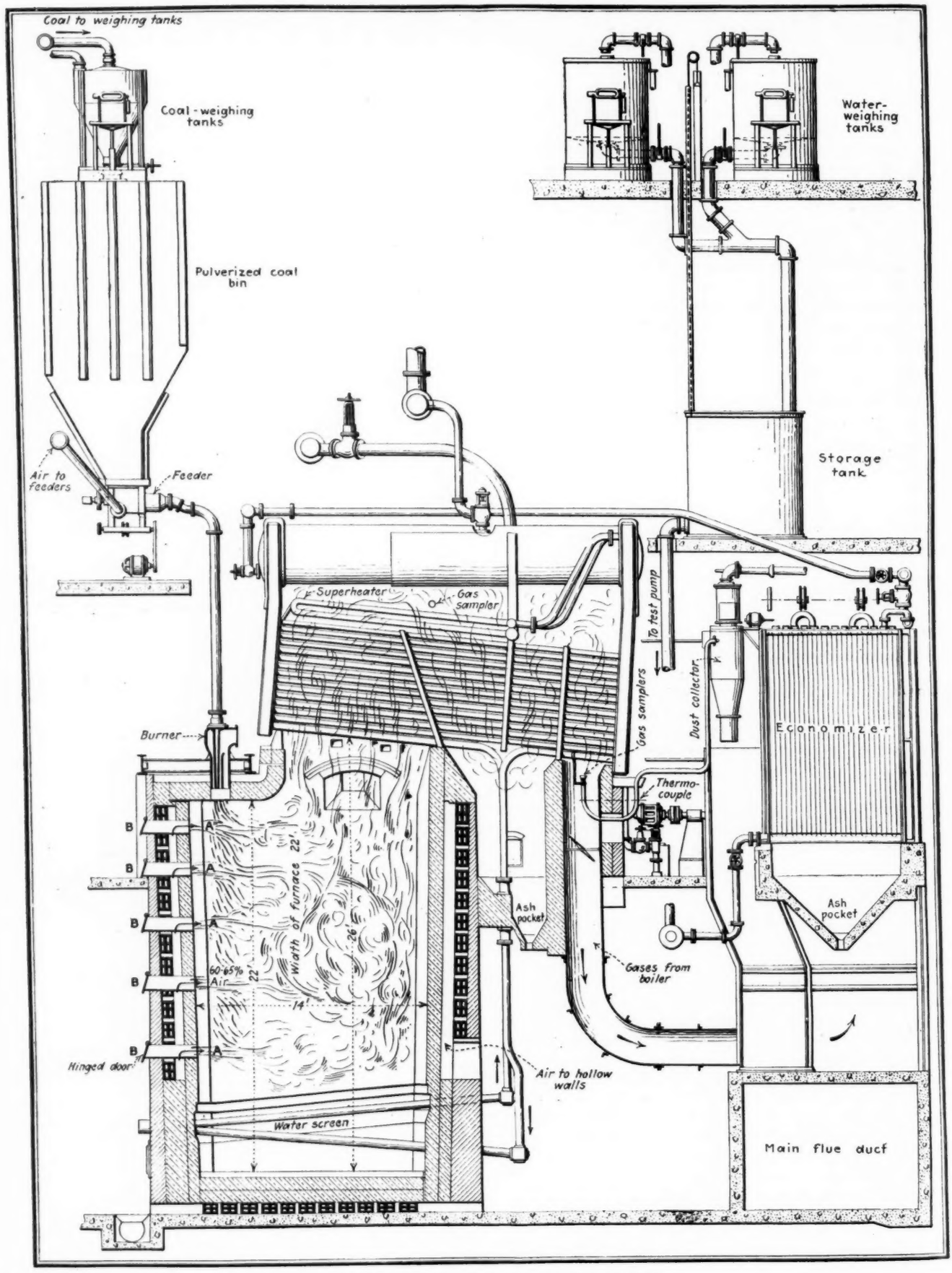


FIG. 2—SECTION OF BOILER AND FURNACE

the dampers *EE* by means of which more or less of the air admitted is allowed to pass down along the nozzle, the remainder passing down the passage *F*. By these adjustments the distance from the nozzle at which the coal ignites is regulated, and when the burner is

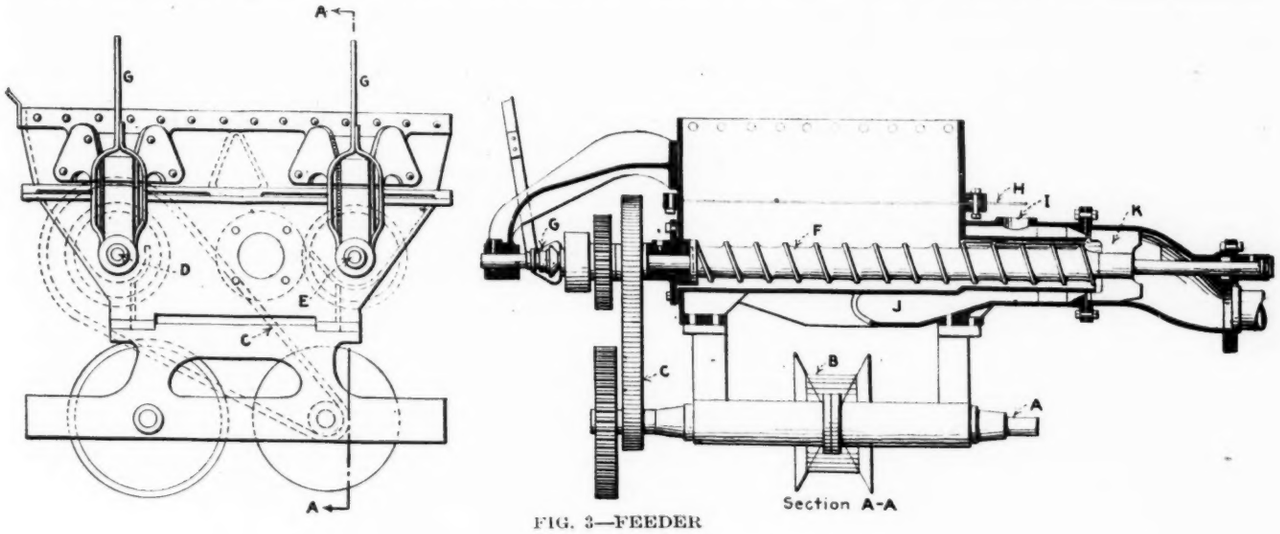


FIG. 3—FEEDER

once set for a given set of conditions, no manipulation of the adjustments is necessary so long as these conditions continue, the air supply here and beyond being regulated by the main boiler damper. Inspection openings with hinged covers are shown at *GG*, and a steam jet at the entrance is provided for emergency use in case of a failure of the air supply or a clogging of the nozzle and to assist in mixing at high rates of combustion.

The furnaces have recently been equipped with automatic draft regulators. The apparatus is controlled by the draft conditions in the furnace, changes being communicated to an inverted bell suspended in water in a chamber connected to the furnace. Suitable gear transmits the movement of this bell and operates a throttle valve in the steam line to the economizer turbine, which in turn varies the speed of the fan controlling the volume of gases handled.

A local firm manufacturing control apparatus is at the present time installing a system of fuel control. The regulating apparatus will consist of a "Mercoid" pressure master gage, operating in conjunction with a timer which will cause the functioning of connected apparatus through the primary shaft of the Reeves drive, which governs the speed of the present coal feeders. The "Mercoid" master gage will respond to a difference of one pound on either side of the predetermined pressure for which the system is finally set.

The installation of this regulating system will result in full automatic operation of the boilers. The only manual attention needed will be that necessary to regulate single burners in which differing conditions may occur as a result of varying moisture or foreign substances in the coal.

The cloud of coal dust entering the furnace at the top front, as shown in Fig. 2, through six of these burners, ignites and a cataract of flame flows downward parallel to front wall. Here it meets a supply of air admitted through the apertures *A*, of which there are 5 horizontal rows 10 wide, making 50 in all. When the room air is used directly, these openings are adjusted by

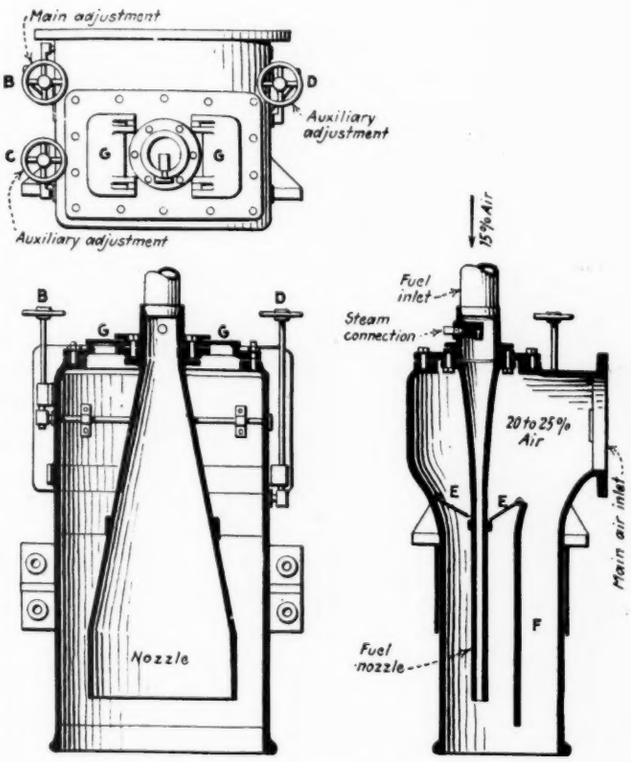


FIG. 4—BURNER

efficiency by the use of the preheated air. The remaining 60 to 65 per cent of the air needed for combustion is introduced in this way.

As a result of this arrangement there is no scrubbing action of the flame against the front wall, and it does not impinge violently upon the furnace floor, but swirls upward without erosive action on the brickwork. A plot of the temperature gradients shows the temperature near the walls to be 1,500 to 2,400 deg. F., the zone of maximum temperature being an elliptically shaped space in the lower center where the tempera-

ture attains some 2,800 deg. The average time afforded to a particle of fuel to pass from the burner through the furnace to the boiler tubes is about two seconds, the flame being U-shaped.

The problem of slagging has been solved by the use of a water screen consisting of a system of 4-in. tubes connected into the circulation of the boiler, as shown in Fig. 1. These are spaced 12 in. between centers in the front header and 24 in. in each of the two rear headers. They absorb about 8 per cent of the heat generated, 40,000 to 50,000 B.t.u. per sq.ft. per hour. This is equivalent to the evaporation of 40 to 50 lb. per hour per square foot of heating surface. It was determined by detaching the screen from the general circulation and actually measuring its absorption.

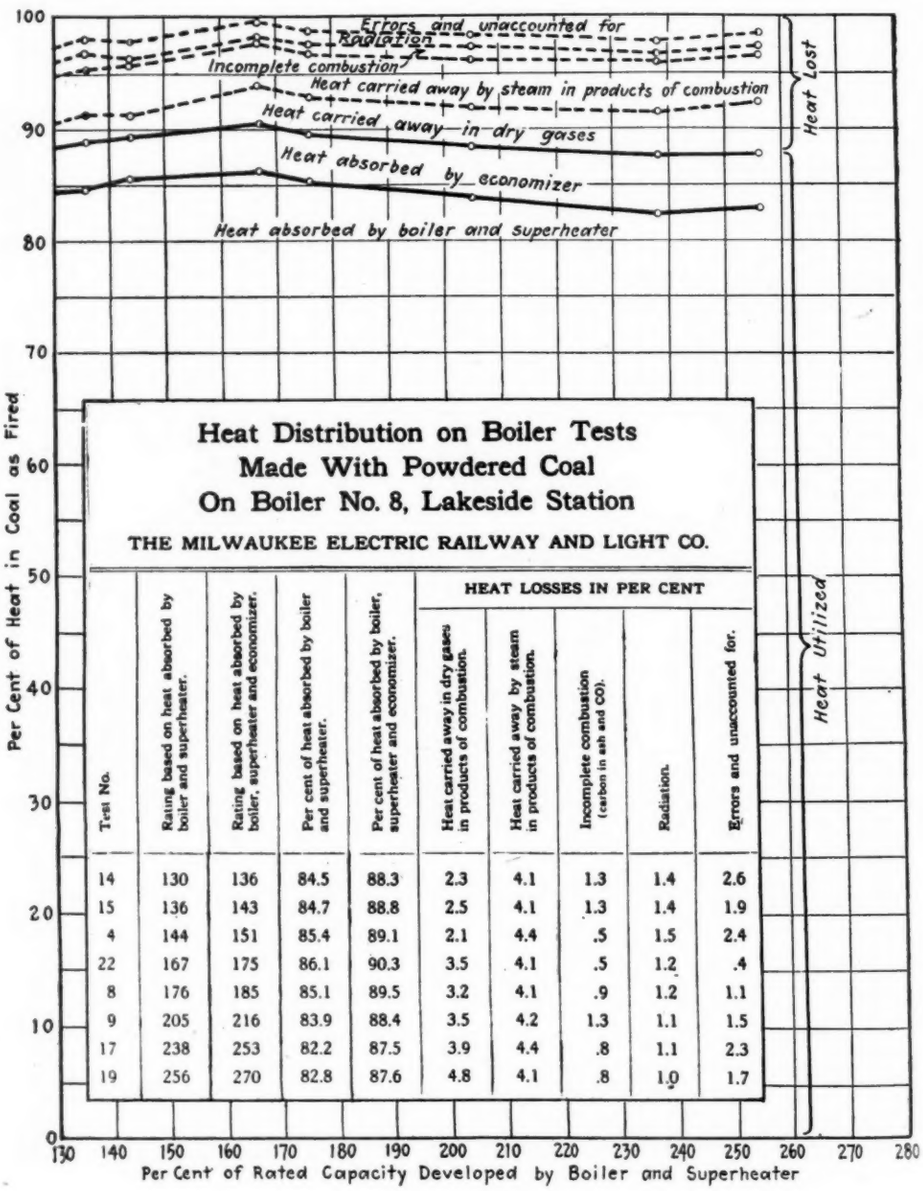
The effect of the water screen is so to moderate the temperature of the lower end of the furnace that the non-combustible that was wont to accumulate and fuse into a vitreous slag, remains in a light friable form, some upon the tubes and some dropping between them to the furnace floor. This is removed about every other day, depending upon the rate at which and portion of time during which the boiler has been in operation. About 25 per cent of the ash content of the coal burned is collected at this point and another 15 to 20 per cent in the passages and ash pockets, from which it is collected with pneumatic steam conveyors. The tubes are blown every eight hours by soot blowers, using nine sections on each side of a boiler. There is some tendency to slag on the tubes, but no more than from coal of the same kind stoker-fired at the same rate and is of a more easily removable character than slag from stoker fires. The soot blower detaches most of it with the coals ordinarily used.

In the flue between the economizer and the chimney there is a large concrete chamber in which the departing gases are washed with a water spray. Here is recovered some 60 per cent of the remaining non-combustible. It is in the form, when dried, of a fine powder, so smooth and free from grit as to suggest its applicability to some useful purpose.

Twenty per cent of the total non-combustible of the coal is carried off in the form of impalpable particles that color the discharge from the chimney a light gray and probably remain suspended in the atmosphere until such time as moisture conditions tend to bring it down again.

Lakeside was the first large station to be built expressly to run on powdered coal and, naturally, every provision was made for working out its problems and watching its efficiency. Every facility for observation and research has been provided. In the interest of the International Combustion Engineering Co., which installed the coal-burning portion of the equipment, Henry Kreisinger, the well-known combustion engineer, made a continuous study of the processes of combustion as carried out in these furnaces. Results of tests at 8 different capacities are given in tabular and diagrammatic form in Fig. 5. The actual over-all results—that is, the ratio of the heat absorbed by the boiler, superheater and economizer to the heat value of the coal as fired—is reported by John Anderson, chief engineer of the Milwaukee Electric Railway & Light Co., and designer of the Lakeside station, to be

	Over-all Including Banking	Steaming
For July	86.77	88.02
For August	86.59	87.82
For September	86.12	87.41



Heat Distribution on Boiler Tests Made With Powdered Coal On Boiler No. 8, Lakeside Station

THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT CO.

Test No.	Rating based on heat absorbed by boiler and superheater.	Rating based on heat absorbed by boiler, superheater and economizer.	Per cent of heat absorbed by boiler and superheater.	Per cent of heat absorbed by boiler, superheater and economizer.	HEAT LOSSES IN PER CENT: Heat carried away in dry gases in products of combustion.	Heat carried away by steam in products of combustion.	Incomplete combustion (carbon in ash and CO).	Radiation.	Errors and unaccounted for.
14	130	136	84.5	88.3	2.3	4.1	1.3	1.4	2.6
15	136	143	84.7	88.8	2.5	4.1	1.3	1.4	1.9
4	144	151	85.4	89.1	2.1	4.4	.5	1.5	2.4
22	167	175	86.1	90.3	3.5	4.1	.5	1.2	.4
8	176	185	85.1	89.5	3.2	4.1	.9	1.2	1.1
9	205	216	83.9	88.4	3.5	4.2	1.3	1.1	1.5
17	238	253	82.2	87.5	3.9	4.4	.8	1.1	2.3
19	256	270	82.8	87.6	4.8	4.1	.8	1.0	1.7

FIG. 5—TESTS

The gradual falling off in efficiency during the month of September may be attributed directly to the nature of the load carried during this month. The fact that Lakeside is the most efficient plant operated by the company causes the bulk of the load to be given to this plant. The carrying of peak loads of 48,000 kw. caused the boilers to be run at about 225 per cent rating, which is beyond the point of economical performance. Had the character of the load been the same as in the previous months, the same 88 per cent efficiency could no doubt have been obtained.

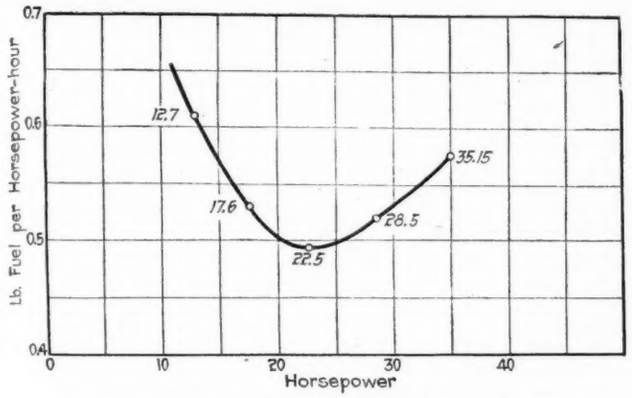
Not the least of the advantages is the quietness and cleanliness of the operation, the absence of the dirt and clutter inseparable from the handling of loose coal in the fireroom. There is no fuel visible, no objectionable dust and none of the roar attending the use of some of the methods of firing fluid and gaseous fuels, while the station has all the neatness of an oil-fired plant.

The station has done a great pioneer work in testing out the applicability and advantages of this method of burning fuel in large power-plant practice and in affording an opportunity for the development of these possibilities. Such a demonstration would be possible only through the combination of an engineer fired with enthusiastic conviction of the value of the process, a using company with the confidence and courage to try it out on a large scale and a selling company disposed to determine and demonstrate its value in real practice at all costs with the most scientific methods and with the organization and facilities to carry it through.

Power hopes, in another article to deal with the methods and cost of pulverization.

A German High-Speed Heavy-Oil Engine

The Deutz works of Germany have developed a four cylinder four-stroke-cycle truck engine which burns heavy petroleum or tar oil. This engine operates on the solid-injection principle and has a fuel consumption



FUEL CONSUMPTION OF GERMAN HIGH-SPEED OIL ENGINE

well under that of prevailing gasoline automobile engines.

The heaviest of petroleum oil or tar oil is burned successfully. The engine may be started either by the usual electric storage battery, by air, or by hand. For the first idle strokes the high compression is relieved. The engine fires regularly at all speeds within the usual range and allows full reduction of speed at all loads.

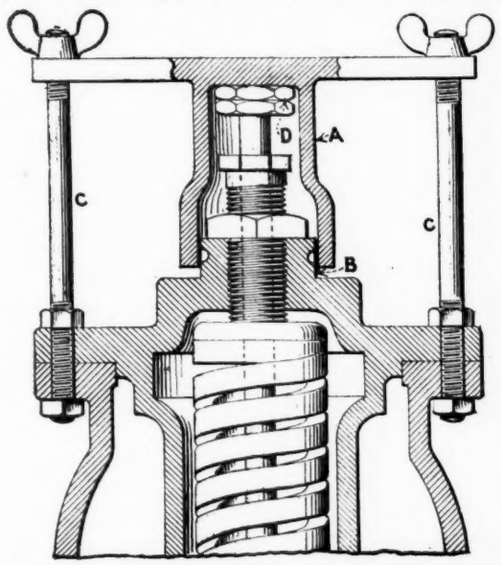
The fuel consumption at 1,000 r.p.m. for various loads is shown in the chart. The lowest consumption compares favorably with the best results obtained from small gasoline engines of the airplane type, and even the highest consumption shown—that is, 0.61 lb. per i.hp. at 12.5 hp.—is more than comparable with the results obtained from tractor engines. It would seem that the designers of this engine have solved the difficulties encountered in other attempts to burn heavy oil in an engine operating at a variable speed and under a wide load range.

A Practical Safety-Valve Clamp

BY JOHN V. EMERY

In clamping safety valves when making hydrostatic tests on boilers, too much care cannot be exercised, as improper clamping may result in a bent or injured stem.

Finding that our old clamps, each of which was simply a bar having a ¾-in. hook bolt at each end for



THIS METHOD OF CLAMPING OBVIATES ANY POSSIBILITY OF BENDING THE STEM

hooking over the valve bonnet and a ¾-in. screw bolt in the center for a bearing point on the valve stem, were a constant source of trouble and required too much time to adjust them on the valve, the clamp *A*, as shown in the cut, was made. This clamp may cost more to make than the original type, but the saving effected in the time required to place it on the valve and the protection it affords to the stem will more than compensate for the higher first cost. The clamp is made to fit over the stem as shown and is a loose fit for the lifting nuts *D* and a sliding fit for the projection *B*.

Two diametrically opposite extension studs *C* are permanently placed in the valve bonnet, replacing two of the regular flange bolts. To put the clamp in place, the cap is removed from the valve and the clamp is dropped over the studs and valve stem. The wing nuts are then screwed up snug on the extension studs.

The one condition that contributes most toward the successful operation of indicating and recording CO_2 apparatus is that of tight joints in both apparatus and pipe lines. In order to insure against leaky joints, a good plan is to have all piping in as straight a line as possible. Another precaution that is sometimes successfully used is to paint all joints with shellac. Eighty per cent of the trouble with CO_2 apparatus is due to leaks.

Vocational Training*

THE A.S.M.E. Committee on Education and Training for the Industries Discusses Correspondence and Extension Courses, Apprenticeship, Shop Training and Industrial Education.

RECOGNIZING that industrial education and training is susceptible of classification and with a view to promoting co-ordination and simplification that may suggest a standard code of procedure in vocational training, the committee presented its report in the form of three papers: "Extension and Correspondence Schools," by Jos. A. Moyer, Director of the University Extension, Massachusetts Department of Education; "Schools for Apprentices and Shop Training," by R. L. Sackett, Dean of Engineering, Pennsylvania State College; and "Industrial Education as Represented in Schools," by C. R. Richards, of the Federal Board of Vocational Training.

According to Mr. Moyer nearly every state now has a correspondence-school system supported by taxation, in addition to the privately organized correspondence schools. These state-supported institutions are usually organized as a department of the state university, where there is one, but in states such as New York and Massachusetts, where there are no state universities, the correspondence instruction is organized and carried out under the supervision of the state departments of education.

Extension Classes

Extension classes are locally organized. The instructors are either members of the faculty of the university or school conducting the classes or persons living in the vicinity in which the class is conducted. Extension classes differ from residence classes in that membership in them is open to all who can give reasonable evidence of their ability to profit by such instruction; and in that these classes afford, so far as is possible in classroom work, individual attention to individual needs.

The problem of making these courses widely available is one of reaching fairly compact, well-centralized groups, and the method of approach is accordingly direct. Agents of the university or schools consult with industrial executives, the representatives of business and social organizations, and school superintendents, and through them discover for what subjects each community has a genuine need. Instructors are then appointed, according to the nature of the courses, from college faculties or from among commercial and industrial specialists. And it is significant of the whole university-extension scheme that an instructor's formal connections and affiliations count less toward his appointment than his ability to give vital, effective instruction.

Comparing the advantages of correspondence and extension courses, Mr. Moyer pointed out that the latter tend to promote a spirit of democracy through the informal manner in which they are conducted in the class room where the instructor fosters the freest discussion by the students. On the other hand, correspondence courses are available to the student at any place or any time and inasmuch as each paper receives the instructor's individual attention, bluffing is out of the question. Moreover, with the personal record and qualifications of the student before him the instructor is enabled to maintain a certain degree of personal relation with him. In both systems every effort is made to have the instruction concrete and tangible.

Apprenticeship and Shop Training

"The object of apprentice training," says Dean Sackett, "is to train a sufficient supply of young men to meet the needs of skilled employees, including foremen and superintendents. It is believed that thorough training stabilizes employment, reduces turnover, gives a better understanding of elementary economics as applied to industry and tends to create a greater interest in and loyalty to the concern."

The railroads and certain of the large industrial concerns have long been strong advocates of the apprenticeship system. They have two classes of apprentices—those having a common-school education and those who have been graduated from technical schools or colleges. Those with a common school education are given class work in mathematics, mechanical drawing, physics and elementary mechanics along with their shop work. Those having a technical education are put on more advanced repair, maintenance design and construction.

In the larger establishments the training often is accomplished under a separate organization, whereas the small firms conduct the training within the production departments.

The expense of maintaining trained instructors who are non-productive is frequently an objection in the eyes of the management. It is difficult to show by figures the reduced time and materials used in learning, the saving in wear and tear on machinery, the saving in the foremen's time, the reduced turnover during the training period, the lessened interference with production, and the greater satisfaction to old employees when they are not asked to break in new men.

Industrial Education in Schools

Thirty years ago the demand was often voiced on the part of employees for trade schools to train mechanics competently in place of the disappearing apprenticeship system. During these thirty years a number of attempts to meet this demand in schools both under private and public control have been made, but in the opinion of Mr. Richards the results and experience gained have not demonstrated that this function is one that can be served effectively by a school.

One reason why schools of this type have not further increased in number is because of the severe economic difficulties under which they labor. First of these difficulties is the problem of support presented to the student or worker during the period of instruction. Trade-school training of the type under discussion is in common practice restricted to the period above sixteen years of age, and as the great bulk of the youths who will form the mechanical and industrial workers of the country must of necessity enter upon remunerative work at sixteen or shortly after, the sacrifices necessary to permit attendance at a trade school can be expected only from a comparatively few. The second aspect of

*Lack of space prevented this being included in the report of the A.S.M.E. meeting in the Dec. 12 issue.

the economic problem in relation to such schools is found in the large expense of administration, instruction, materials, and physical maintenance in proportion to the number of students that can be instructed.

Preparatory industrial training or pre-employment trade training is represented in its most important phase by schools under public control, called vocational schools, industrial schools or unit-trade schools. These schools have arisen largely from the discovery of the fact first brought out by the report of the Massachusetts Committee on Industrial and Technical Education in 1906 that in the case of the large number of boys entering employment at 14 years of age, the two years following are largely wasted as far as progress toward a skilled trade is concerned.

A group of schools, small in number but performing most important work in mechanical and electrical fields, have been developed in various parts of the country in the last thirty years. These schools offer a technical training above that of the trade school and below that of the engineering school, aiming, in other words, to equip the technical expert, designer, inspector, tester, overseer, shop superintendent and power-plant superintendent, in short, the non-commissioned officers of industry. Prominent among these schools are Pratt Institute, certain departments of the Carnegie Institute, the Ohio Mechanics Institute, the Lewis Institute, the Wentworth Institute, and the Dunwoody Institute. Such schools comprehend courses in machine construction, electrical construction, industrial electricity, steam and electrical power-plant practice, foundry management and operation, machine design, industrial chemistry and courses called industrial mechanical engineering and industrial electrical engineering. The courses generally extend two years in length although in certain schools they carry beyond this time.

In opening the discussion on his own paper, Professor Richards gave as the object of the educational committee, in preparing its report, the desire to present a diagram of what is being done—to record the facts, so that confusion might not arise when reference was made to various classes of schools. He said that we cannot expect the trade school ever to be an important factor in training for industry, because of the great expense in maintaining such schools, and because of the difficulty experienced by many trade school students in supporting themselves during the period of instruction. Professor Richards then contributed his bit on the question of "Breadth versus Specialization," previously raised by Mr. Moyer and Professor Anderson. Life has differentiated education lately, he said. Certain boys and girls must stop at various phases in the educational ladder. We are obtaining constantly diminishing returns from the old educational methods as applied today. All our schools, both private and public, are tremendously in need of helpful criticism, and it was Professor Richards' belief that much of this criticism should come from mechanical engineers.

A. L. Williston, principal of Wentworth Institute, Boston, concurred with Professor Richards in that the different lengths of educational periods precluded the possibility of uniformly broad training. To further the work of the Committee on Education and Training for the Industries, he suggested that every member of the A.S.M.E. obtain and record data as to how the workers in his plant are improving themselves.

Speaking on education in general, Professor F. P. Anderson expressed opposition to the idea of training for the "lower jobs." We should give as broad an education as possible, he said, with reference to the time to be spent in school. Not only in the high school but in the university, as well, is there too much specialization. The broader the education a man receives, the better the technician he will make. Many engineers graduate from college without having learned to write decent English. Many college men take ten or more years to get the corners knocked off before they are of value to industry. Professor Anderson said that a man's greatest growth should come after he had left college, through reading and studying the best in literature. But the universities do not always make the great leaders—many come from below, learning the bigger things through their own efforts.

An excellent summary of the report and discussion was given by Ira M. Hollis, president of Worcester Polytechnic Institute and past president of the A.S.M.E. The tendency today, he said, is not to educate for menial positions, but to train for the best citizenship. All education must train men, first to make a living, and second, to use their spare time for advancement, intellectual as well as professional.

The Design of Cooling Towers*

By C. S. Robinson

The factors influencing the design of cooling towers have been studied by a number of investigators. There has been, however, no statement of the influence of these factors of such a nature that it has been possible to calculate easily the performance of a given tower under widely varying internal and external conditions. In the absence of anything but empirical information, towers are, therefore, constructed along certain well-established and successful lines. Thus the designer of the forced-draft tower allows the water to fall through a height of perhaps 22 ft., and proportions the ground area on the basis of 6½ gal. per sq.ft. of ground area per minute. However, this empirical knowledge will not enable the engineer to predict what will happen when conditions depart widely from standard practice, as, for instance, the capacity of a tower 11 ft. or 44 ft. high.

The equation used universally by engineers at the present time in cooling-tower problems is

$$w(t_1 - t_0) = W_s(T_1 - T_0) + W_r(H_1 - H_0)$$

where s and r are the average humid heat and latent heat between the top and bottom of the tower, respectively; t is temperature of the water; w is the weight of water; W is the weight of air (moisture free) entering the tower; T is the temperature of the air, and H is the percentage of water vapor in the air.

The subscripts 1 and 0 refer to the top and bottom of the tower, respectively.

The mechanism by which the heat passes from water to the air may be understood by considering that the heat flows first from the interior of the water to the surface and then from the surface through a substantially stationary air film in contact with the surface to the moving air.

The temperature difference between the water and the air in a counter-current cooling tower does not change greatly between the top and bottom of the tower, nor does the difference in humidities between the water and air. It may be said that for the whole tower the

*Abstract of paper presented at the annual meeting of the A.S.M.E., Dec. 4-7, 1922.

total increase in humidity of the air is to the total increase in temperature of the air as the arithmetical mean humidity difference between the air and the water is to the arithmetical mean temperature difference between the air and the water.

It has been noticed by others that the rate of cooling in towers is approximately proportional to the air velocity. Investigations being carried on at the present time indicate that ka for humidifying apparatus in general is probably proportional to a power function of the air velocity something less than one, but for the present, at least, linear proportionality is a fairly close approximation. Here k is the actual coefficient of diffusion per square foot of surface. Since in many types of towers the active surface cannot be accurately measured, the coefficient ka is used instead, a being the actual surface in square feet per cubic foot of tower.

The author calls the value $\frac{ka}{u}$ the "tower constant," u being the linear velocity through the total cross-section of the tower. For one tower investigated the average value of $\frac{ka}{u}$ was 0.0037 and the average deviation from this value was 0.00021, or less than 6 per cent, while the maximum deviation was 0.0006, or 16 per cent. The important thing indicated by the tests given in the paper is that $\frac{ka}{u}$ was unaffected whether the tower was operated with forced or with natural draft.

The coefficient $\frac{ka}{n}$ expresses the volumetric capacity of any particular type of tower. Experimental determination of this constant is necessary before design can be accomplished.

In general, certain specifications must be met. These may be:

The weight of water to be cooled, w; temperature of water to be cooled, t_1; temperature to which water must be cooled, t_o; average (or worst) outside air temperature, T_o; average (or worst) outside air humidity, H_o.

There are in most cases three unknown conditions—the temperature and humidity of the outgoing air, and either the volume of the tower or the ratio of the amount of air to the amount of water. The air-water ratio is usually determined by the type of tower selected and is therefore known, leaving the volume of the tower as the third unknown.

By the equations developed by the author these values may be developed as follows:

$$T_1 = -T_o + t_1 + t_o - \frac{\frac{2w(t_1 - t_o)}{kaAx}}{s + r\frac{2H_o - P_1 - P_o}{2T_o - t_1 - t_o}} \qquad (11)$$

$$H_1 = -H_o + P_1 + P_o - \frac{\frac{2w(t_1 - t_o)}{kaAx}}{s\frac{2T_o - t_1 - t_o}{2H_o - P_1 - P_o} + r} \qquad (12)$$

$$W = -\frac{\frac{w(t_1 - t_o)}{s(2T_o - t_1 - t_o) + r(2H_o - P_1 - P_o)}}{1 + \frac{2w(t_1 - t_o)}{kaAxs(2T_o - t_1 - t_o) + r(2H_o - P_1 - P_o)}} \qquad (13)$$

These equations become much simplified when the known numerical values are substitutes for the literal quantities. The author felt that this method of calculation is distinctly in advance of anything which has thus far appeared in print, that it furnishes a convenient and accurate tool for the designing engineer.

Locating Reversed Armature Coils with a Wattmeter

BY A. S. McCLAIN*

The usual method of testing for faults in a direct-current armature, by sending a current through the winding and taking readings with a millivoltmeter on each pair of adjacent commutator segments, will not give an indication of a reversed coil in the winding. The usual method of locating this fault is with a compass when a current is passed through the armature from an outside source. There are two cases of reversed coils that may occur in connecting up an armature winding. One is where a coil may be formed the reverse from the rest in the winding or its leads crossed when they are connected to the commutator, as at *B* in Fig. 1. The other is where two pairs of leads are crossed on the commutator at *A*. In the latter case a reversed reading will be obtained on a millivoltmeter if connected to segments 4 and 5.

Assume Fig. 1 to represent part of an armature winding and that a current is passed into the winding at segment 1 and leaves by segment 11. Under this condition current will flow through the winding as indicated by the arrows. If a millivoltmeter is connected to segments 1 and 2, it will read the potential drop between these two segments, which will be that across one coil. The direction of current flow through the meter will be as indicated by the arrowheads. When the meter is connected to segments 3 and 4, it will read the potential of coils 3 and 4 in series, consequently will give a reading double that of normal. When connected

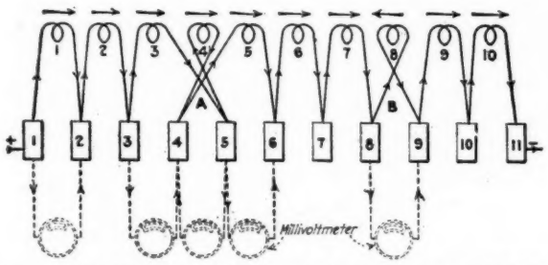


FIG. 1—SIMPLIFIED DIAGRAM SHOWING ARMATURE TEST WITH DIRECT CURRENT AND A LOW-READING VOLTMETER

to segments 4 and 5, the potential of coil 4 will be applied to the meter terminals, but this will be in the reverse direction, as indicated by the arrowheads on the meter leads, and a reverse reading will be obtained, indicating that the coil leads that connect to these two segments are crossed. If a reading is taken from segments 5 and 6, it will be double normal, or that of coils 4 and 5 connected in series. Where two pairs of coil leads are crossed on the commutator, a double reading will be obtained, then adjacent to this a reversed reading and then a double reading.

When a coil is reversed as at 8, connecting the meter to segments 8 and 9 to which the coil connects, a normal reading will be obtained, since the current flows through

*Shoshone Electric Light & Power Co., Cody, Wyo.

the instrument in the same direction as when the coil is connected properly. The usual way of locating such coils is with a compass which at best is not any too reliable a method, especially if all the coils are connected to the commutator.

When the armature coils have a voltage induced in them—for example, by exciting the field coils with an

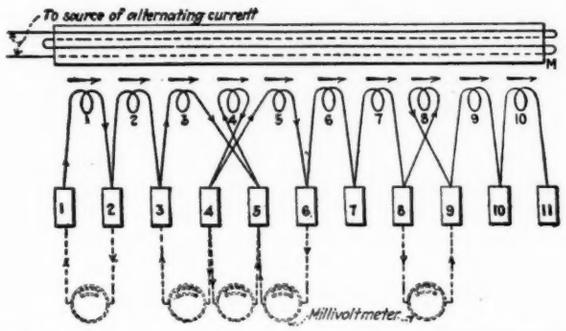


FIG. 2—SIMPLIFIED DIAGRAM SHOWING ARMATURE TEST WITH ALTERNATING CURRENT AND A LOW-READING VOLTMETER

alternating current—the instantaneous flow of current from the reversed coil to the external circuit will be the opposite to that in the coils that are connected correctly. This will be understood by referring to Fig. 2. Assume that the armature coils are in the field of magnet *M*, which is excited with alternating current. The alternating magetic field will induce an alternating voltage in the armature coils, which we will assume has an instantaneous direction as indicated by the arrows. If segments 1 and 2 were connected together through a voltmeter, the voltage in the coil No. 1 would set up a current that would flow from segment 2 to segment 1 and around through the coil, and only one coil would be in the circuit. Connecting segments 3 and 4 together closed the circuit through coils 3 and 4 in series, and the voltage will be double that of one coil, but the direction through the meter will be the same. When the meter is connected to segments 4 and 5, it will close the circuit through coil 4 only, but the direction of flow through the meter will be reversed. Connecting the meter to segments 5 and 6 closes the circuit through coils 4 and 5 in series, therefore the reading will again be double that of one coil, but the flow is in the normal direction. When connected to segments 8 and 9, the circuit is closed through coil 8, but in this case the flow through the meter is reversed from normal. Of course, this being alternating current, an alternating-current instrument must be used and will give a positive reading irrespective of the current's direction, flowing through it, therefore will not give an indication of the reversed coil. However, the fact that a reversed current can be obtained in the external circuit provides a means of locating the reversed coil by use of a wattmeter, and is the method I have developed for this purpose.

This scheme consists of a means of magnetizing the armature with an alternating field, from a source of alternating current and a rotating-standard wattmeter. The armature can either be magnetized by a testing magnet, or it can be placed in its own frame and the field coils connected to a source of alternating current. The machine I made the test on was a ½-hp. direct-current motor with 50 coils in the armature winding; when the test was made, it was found that 11 coils were reversed in the winding. After these were corrected, the motor operated satisfactorily.

From Fig. 3 it may be seen that the shunt-field winding is made the equivalent of the primary of a transformer and the armature coils the secondary. In using the rotating standard, the potential coil is connected to the line in the usual manner and two leads brought to the commutator and a bar to bar test made similar to making a test with a telephone receiver or low-reading voltmeter. When these test leads are connected to adjacent segments, the coil connected to these segments acts as the secondary of a transformer to cause a current to flow through the current coil of the standard. With the leads connected in the right relation, the meter will rotate in the forward direction. Say that the meter was connected to segments 1 and 2, Fig. 2, and a forward rotation was obtained, as would be the case on all correctly connected coils; then when the meter is connected to segments 8 and 9, coil 8 will set up a reversed current in the standard's current coil and it will reverse its direction of rotation, showing that the armature coil is reversed.

When the two pairs of coil leads are crossed on the commutator, as on segments 4 and 5, a fast reading will be obtained on the standard when connected to segments 3 and 4, a reversed reading from segments 4 to 5 and a fast reading from segments 5 and 6. These readings will allow distinguishing between where the coil is reversed and where the leads are crossed on the commutator.

One of the test leads should be marked so that they can always be connected to the commutator in the same

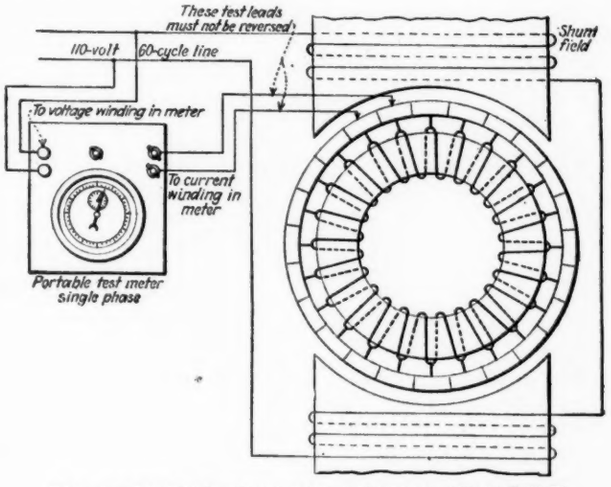

These test leads must not be reversed
Shunt Field
110-volt 60-cycle line
To voltage winding in meter
To current winding in meter
Portable test meter single phase

FIG. 3—CONNECTIONS FOR TESTING ARMATURE WITH ROTATING STANDARD

relation. All the readings should be taken from the same location on the commutator, at a point where a suitable voltage is obtained for the current coil of the instrument. A wide range of voltage will be found on the commutator, ranging from zero for coils directly under the center of the polepieces to a maximum value between the poles. Of course, this maximum voltage will be low, probably amounting to a fraction of a volt. All tests must be taken from the same relative position on the commutator, and the armature turned as the tests are made to maintain this position. Where sufficient voltage cannot be obtained with the shunt-field coils in series, they may be grouped in parallel, care being taken to maintain the correct polarity.

Unaflow Engines for Compressor Drive

Description of New Worthington Unaflow Engine-Compressor—Governing Device—Method of Setting the Steam Valves

AIR compressors, as a rule, are seldom operated at their maximum capacities. In consequence, if the machine be motor-driven, the decrease in motor efficiency and power factor may make this drive undesirable. Low loads are exceptionally unfavorable to the usual engine whose efficiency drops sharply from full to half load. The unaflow engine has a fairly flat efficiency-load curve and for this reason is being used on many compressor drives.

In Fig. 1 is shown the Worthington unaflow-engine-driven air compressor. This is a duplex unit with the steam cylinders bolted to the frames and carrying yokes or distance pieces to which are bolted the air cylinders. The cranks are set at 90 deg., as this arrangement is best for air-compressor service.

The unaflow cylinder is a plain barrel casting with the exhaust ports in the center, and with flanged ends. The cylinder heads are completely steam-jacketed by the steam feed. The steam valves, which are set horizontally in the bottom of the cylinder heads, are of the double-beat poppet type. The valve details appear in Fig. 2. The valve is a cast-iron body *E* sliding on an extension *F* of the valve bonnet. This valve rests on the cylinder-head casting and carries a second seat *G* which is a light steel ring shrunk onto the valve body. This ring is sufficiently flexible to take care of the difference in expansion of the cylinder-head casting and valve body.

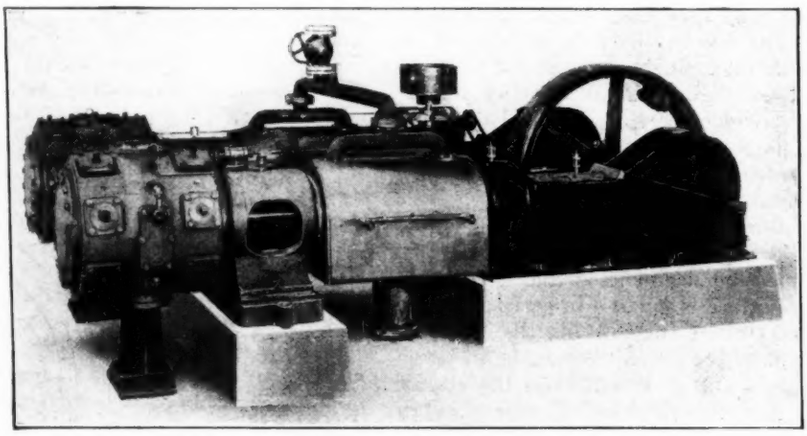


FIG. 1—WORTHINGTON UNAFLOW ENGINE-COMPRESSOR UNIT

The valve stem passes through the valve bonnet, being supported by the latter along the full length. To provide lubrication for the stems, an oil passage is drilled through the bonnet connecting with a spiral groove on the stem; oil passes along the groove to the end of the valve and so lubricates the valve stem and sleeve.

The valve stem carries a piston cap and tappet *C*, which latter is engaged by the cam lever *B*. The valve action is as follows: The engine is provided with a layshaft geared to the crankshaft. Two cams, one for each cylinder end, are fitted to a camshaft which is engaged by the layshaft by means of a feather key; one of these cams is shown in Fig. 3. The rotation of the layshaft causes the nose of the cam to strike the cam lever roller, which is connected by a link *A* to the valve lever *B*. The motion of the cam is thus transmitted to the valve, which is lifted off the seats, admitting steam to the cylinder. In duplex engines two sets of cam rockers are provided for each cam, as indicated in Fig. 3.

The speed governor is mounted directly over the governor box and is driven by means of bevel gears from the layshaft. The pressure governor is mounted on the base plate between the cylinder housings and is essentially of the diaphragm type. The discharge air pressure exerted against the diaphragm overcomes the weight arm resisting the movement of this diaphragm, and the movement of the weight arm operates a small pilot valve which in turn admits liquid pressure to the operating piston. Movement of the piston is transmitted through an adjustable rod to a push pin pressing against the bell crank that moves the camshaft. Operating at anything below the discharge pressure for which the governor is set, the engine will run at the maximum speed for which the speed governor is set. When the desired discharge pressure is reached, the pressure element exerts an additional force against the bell crank, slightly shortening the cutoff, which slows down the machine. It will be seen that as the machine slows down, it is necessary that the pressure element be sufficiently powerful to overcome the action of the speed governor, and this is the case with any liquid pressure in excess of approximately 25 lb per sq.in. As the discharge pressure falls very slightly, the pressure element recedes and the bell crank lengthens the cutoff, due to the subnormal position of the speed governor, thus maintaining practically a constant discharge pressure.

The liquid pressure used in operating the pressure element is usually taken from the water service in the building, but where necessary this pressure can be supplied by a very small gear pump driven from the layshaft of the engine, and in this case the liquid used is a light grade of lubricating oil, so as to eliminate wear in the gear pump.

Fig. 3 shows the manner in which the valve-rod connection is made to the opposite cylinder. The main engine cranks are set at 90 deg. and likewise the rollers in contact with the head-end cam are spaced 90 deg., and the same is true of the rollers on the crank-end cam. The cams in turn are keyed to the shaft at 180 deg. In this way the setting of the four steam valves is fixed and the only valve setting necessary is the exact position of the bevel gear on the main engine shaft, as the position of this gear determines the lead, or admission. The lead should be such that each valve is ¼ in. open with the engine on the respective dead center. The exact position of this gear can better be determined

by the use of a steam-engine indicator. The lobe of the cams is tapered so that with the speed [illegible] in its lowest possible position the cutoff in each cylinder is approximately 50 per cent, while with the governor in its highest possible position the cutoff is zero. The

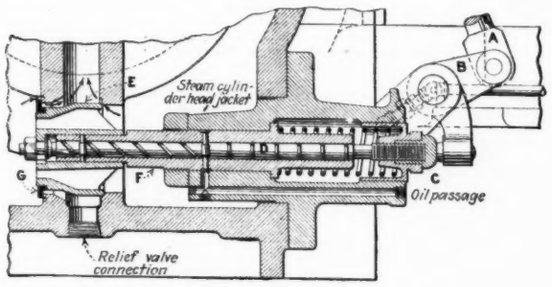


FIG. 2—DETAIL OF STEAM VALVE

admission side of the cam lobe is a straight line parallel to the axis of the camshaft, thus maintaining the same admission point regardless of the cutoff. The back, or cutoff, side of the cam is tapered so as to give the range of cutoff stated.

The only other adjustment of the valve gear is the clearance of the tappets. This clearance should be

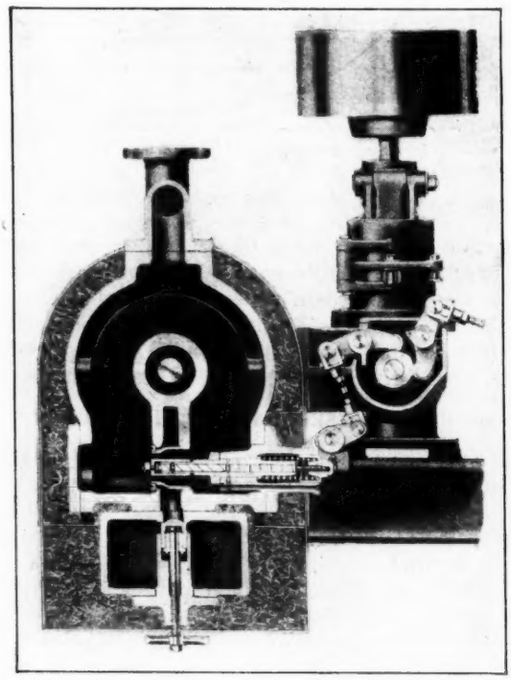


FIG. 3—VALVE GEAR AND GOVERNOR

0.002 to 0.003 in. when the engine is warm, the adjustment being easily made by changing the length of the valve rods *A*. The amount of this clearance can very readily be determined by simply inserting a thickness gage between the tappets. This clearance should be as stated when the roller is on the base circle of the cam and not on any part of the lobe. If this adjustment is not approximately correct, the valve will either be noisy and have insufficient lift, or will remain slightly open at all times, resulting in a loss of economy and rapid wear of the valve seats.

This engine is of the Stumpf type having 90 per cent compression and does not use any auxiliary exhaust. Fig. 4 shows the steam cylinder with a condensing or close-clearance piston for condensing operation. When built for condensing operation, a clearance chamber is attached to each of the heads and, by means of a convenient hand-operated valve, can be thrown into communication with the cylinder. These pockets, when

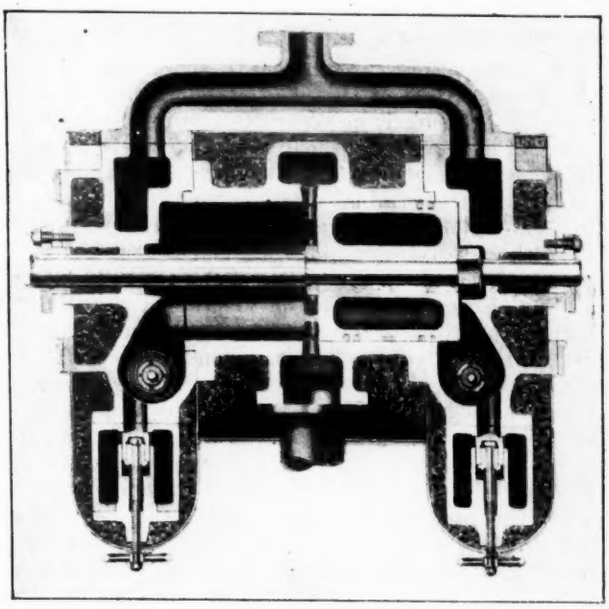


FIG. 4—CROSS-SECTION OF STEAM CYLINDER

open, permit the engine to operate economically non-condensing. When an engine is built primarily for non-condensing service, the required clearance volume is put in the cylinder by recessing the faces of the piston.

[This is the ninth of a series of discussions on the several unaflow engines built in this country, including methods of setting the valves. The tenth and final will appear in the Dec. 26 issue.—Editor.]

Crankpin Clearances

The clearance for the crankpin of a semi-Diesel engine should not exceed 0.02 in. and may be determined by jumping the piston. With regard to the value of side play between the big-end bearing and the crank web, this of course differs in various makes of engines. Some demand more liberal clearance than others if the brass does not bind after warming up. A fair value is $\frac{1}{64}$ in., or just enough to be detected by using a small pinch bar between the rod and crank web.

When first started or after a new bearing is installed, an engine should be run without load for a couple of hours. If a bearing runs hot in service, it never pays to shut down, for the babbitt will surely grip the pin. The load should be thrown off and the engine run at a slow speed, with the lubrication increased, until the bearing cools off. The chief difficulty the engineer meets with is that of obtaining a bearing all along the babbitt. If one end is scraped a trifle low, the pin rests upon only half of the liner or is thrown out of alignment, causing the rod or piston to bind. When scraping the babbitt, a uniform thickness of the shell should be maintained throughout its length.

Compression Pressures in the Solid-Injection Engine

THE Diesel engine requires a compression pressure of 450 pounds per square inch. The solid-injection engine uses only 300 to 350 pounds compression to cause ignition of the fuel. This discussion goes into the reasons for this variation in compression requirements.

ENGINEERS have become accustomed to high compression pressures in the Diesel engine. The general statement that 450 to 500 lb. per sq.in. compression pressure is necessary to insure self-ignition of the fuel is accepted without question. It is surprising to some to know that solid-injection oil engines, using no hot surfaces or other means of fuel ignition, are able to create a temperature above the igniting point of fuel oil with a pressure of but 300 pounds.

In both the air-injection Diesel and the solid-injection oil engine the ignition of oil is brought about by the high temperature of the air charge in the working cylinder at the end of the compression stroke. The final temperature with different compression pressures and with various initial temperatures is shown in Fig. 1. In all the curves the initial or suction pressure is assumed to be 15 lb. absolute, or 0 gage, while the initial temperature T is as shown. If pure air is compressed in a non-conducting cylinder, the process will be adiabatic and the final temperatures are found by following the full-line curves. The exponent n for adiabatic compression of air is approximately 1.41, but in the Diesel engine there is a considerable loss of heat to the cylinder walls and the final temperature is lower than it would be if the value of $n = 1.41$ applied. From a study of compression and expansion curves it seems that n

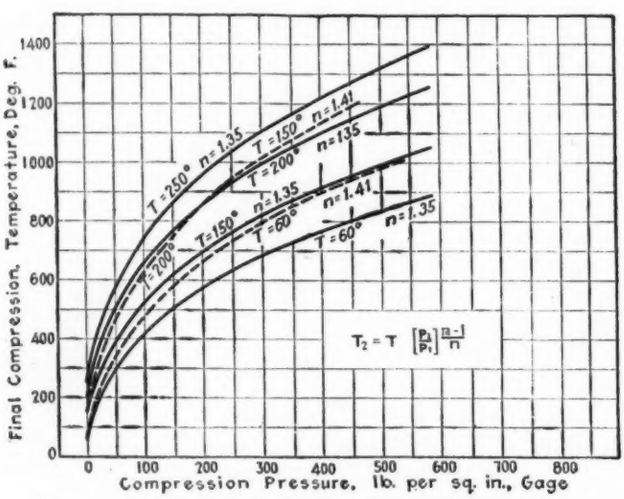


FIG. 1—RELATION OF COMPRESSION TEMPERATURE TO COMPRESSION PRESSURE

ranged from 1.2 to 1.5, averaging about 1.35. Individual cylinders, however, show different values of the exponent. As example, one Diesel engine gave the following average values:

No. of Cylinder	VALUE OF n Compression	Expansion
1	1.396	1.67
2	1.371	1.207
3	1.344	1.183
4	1.378	1.244

The broken-line curves in Fig. 1 give the temperatures when the exponent n is taken as 1.35.

In the air-injection Diesel the pressure ranges from 480 to 520 lb. gage, while in the solid-injection oil engine compression pressures range from 280 lb. to 450 lb. gage, depending upon the engine design. Upon examining Fig. 1, it will be found that, assuming an initial

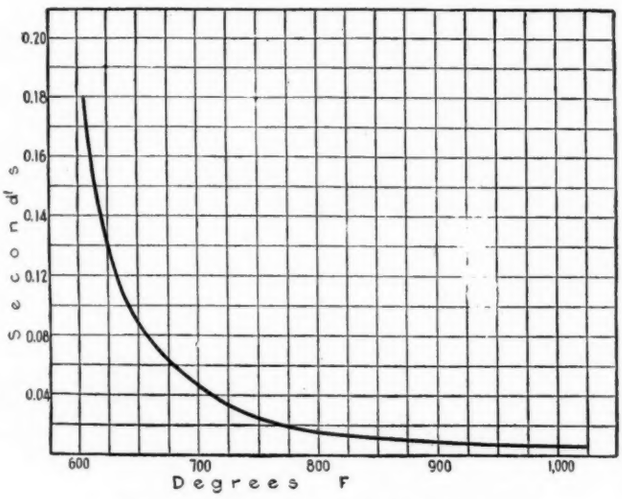


FIG. 2—TIME LAG IN OIL IGNITION

or suction temperature of 60 deg. F., a Diesel compression pressure of 480 lb. gage would cause the air at the end of the compression stroke to attain a temperature of 815 deg. If the solid-injection engine has the same heat loss, so that the exponent n is 1.35, a pressure of 300 lb. would give a temperature of less than 700 deg. F.

Compression Pressure Required

The question is how, in the solid-injection engine, the temperature of the air charge can be high enough at 300 lb. to ignite the fuel, while the Diesel requires 480 lb. compression to insure ignition. The explanation usually offered is that the injection air which blows the oil charge into the Diesel cylinder causes a refrigerating effect by expansion from its original pressure of 900 lb. to the cylinder pressure of 480 lb. In the solid-injection engine no injection air is used since the fuel is injected by the direct action of a pump, and, so it is claimed, no refrigerating effect occurs. A lower compression pressure will then give a temperature sufficiently high to ignite the oil.

But the temperatures at 300 and 480 lb. air, with 60 deg. suction air, are 680 and 830 deg. respectively, a difference of 150 deg., if the same exponent of 1.35 be assumed. The question naturally arises, Will the cooling effect due to the free expansion through the spray valve cause the entire cylinder charge of air to suffer a temperature drop of 290 deg.? With the injection air at 200 deg. F. and 900 lb. pressure the temperature drop in the injection air, assuming no loss of heat, or free expansion, will not exceed 50 deg. F. On the basis that

the injection-air weight is 8 per cent of the weight of the air charge, the lowering of the air-charge temperature would be less than 5 deg. If it is assumed that the heat equivalent of the work of forcing the oil, which is at a high pressure, into the cylinder, where a lower pressure exists, is lost, then the adiabatic temperature drop of the injection air will not exceed 120 deg., reducing the cylinder-air temperature by some 10 deg. Obviously, if the temperature drop occurs throughout the cylinder-air volume, the cooling will be insignificant. Even if injection air and oil spray alone experienced

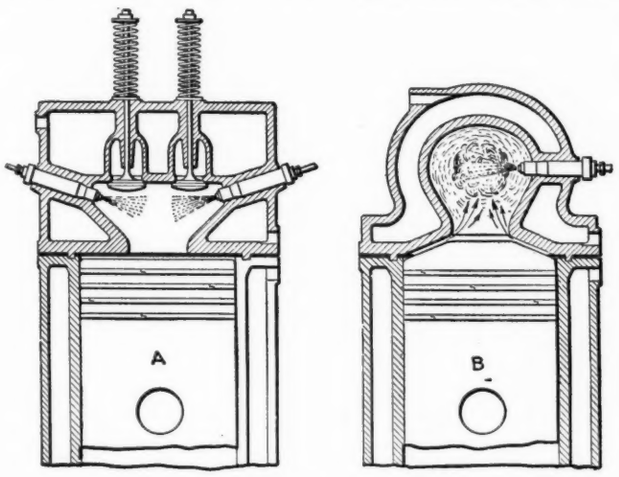


FIG. 3—SOLID INJECTION COMBUSTION CHAMBERS

the drop in temperature, its effect on ignition would be insignificant, for each particle of oil that by its cooling effect is at, say, 100 deg. F., is at once brought into intimate contact with a mass of air at 830 deg. F. The air-charge temperature would not drop lower than 780 deg. even if the entire mass of oil were injected instantaneously. In the actual operation ignition in a Diesel takes place before the entire oil charge enters the cylinder.

Reason for Higher Temperature

This temperature drop is negligible and does not compare with the decreased temperature resulting from leaky and worn pistons. It is extremely doubtful if this so-called air refrigeration has any material effect on the temperature required in the engine.

The higher temperature required by the air-injection Diesel as compared to the solid-injection engine, may be traced to the method and time of fuel injection, to the vaporizing of the oil after introduction and to the difference in the heat loss during compression.

When a substance such as water or oil changes its state from that of a liquid to that of a vapor, a certain amount of heat is required to raise the temperature of the liquid to the temperature at which it will boil at the existing pressure. The specific heat of oil is about 0.43 B.t.u. per pound per degree of temperature rise. After the boiling temperature is reached, before the liquid will vaporize, a certain amount of heat, depending upon the pressure and upon the character of the substance, must be added. This, the latent heat of vaporization, is in the case of oil about 170 B.t.u. When the oil reaches the boiling temperature, no further rise of temperature occurs until this latent heat has been added, whereupon the vapor continues to absorb heat at a rising temperature until combustion occurs. The higher the temperature of the cylinder air the faster will be the ratio of boiling or vaporization and the shorter will be the time interval between fuel injection and ignition. In Fig. 2 is a curve showing the time lag found by Commander Hawkes when using shale oil. There is every reason to assume that this fairly approximates the results to be expected from fuel oil.

Requirements to Insure Ignition

It appears that the oil engine's compression pressure may be lower than that usual in a Diesel, but if so, the fuel must be introduced sufficiently long before dead center to allow evaporation and ignition at or closely after dead center, and the heat loss to the iron walls must be reduced. There is a practical limit to the permissible time given the oil to vaporize before dead center. If the engine operates at 180 r.p.m. or covers 1,080 deg. of the crank circle per second, a time interval of 0.02 sec. means 23 deg. This is as early as it is advisable to inject the oil. This being true, the cylinder temperature to produce ignition with this time interval must be 780 deg., as shown in Fig. 2. Turning to Fig. 1, it will be noted that with 300 lb. compression and with a heat loss corresponding to the Diesel loss an engine will give a final temperature of only 680 deg. This is less than required, and it is evident that the rate of heat loss during compression must be reduced in order to obtain 780 deg. final temperature. With an exponent of 1.41, the same as for air, the temperature at 300 lb. will be close to 780 deg. It is obvious, then, that if the solid-injection is to function, not only must the oil be introduced early to permit vaporization, but the compression curve must be nearer adiabatic than is the curve of a Diesel, and in addition the oil spray must not come into contact with the cool cylinder walls which will condense the spray, causing a missed ignition. To limit the cooling loss, the combustion chamber of the solid injection engine is made as compact as possible to give the greatest volume with the least surface area. Two forms of combustion chambers are shown in Fig. 3. In Fig. 3*B* the center of the chamber holds a mass of highly heated air into which mass the oil spray is injected. The oil spray is by no means so thoroughly broken up as in case of air atomizing. To obtain mixing of the air and oil, the piston is provided with a boss which fits fairly closely into the combustion chamber neck. The result is that a conical ring or stream of hot air is forced up into the combustion chamber just before dead center. This completes the mixing and adds the extra heat needed to ignite the oil.

Typical Combustion Chambers

In the cylinder shown in Fig. 4*A*, two fuel nozzles at opposite sides of the combustion chamber throw streams of oil toward the center. The shape of the two oil streams is such that the oil spray is spread to all parts of the combustion space, but does not strike the iron walls, thereby avoiding cracking of the oil. In addition, the intermingling of the two sprays creates considerable agitation or turbulence of the air, thereby assisting in the thorough mixing of the air and oil.

This combustion chamber does not have as advantageous a shape as the one in Fig. 3*B*. The heat loss to the walls is greater, and as a result the compression pressure must be higher. To obtain positive ignition upon starting with 60 deg. initial air temperature, the compression pressure must be approximately 330 lb.; after the engine is warmed up, causing the initial temperature to be from 100 to 150 deg., a compression of

250 lb. is enough to insure positive ignition. In case of Fig. 2*B* the pressure may be as low as 250 lb. This is a fair comparison of the rates of heat loss during compression. This loss depends upon the amount of surface per unit volume of the combustion chamber, hence the necessity of a well designed cylinder head.

Numerous designs of solid-injection medium-pressure combustion chambers have been built; all of any merit provide for a low heat loss, turbulence of the air charge, avoidance of contact of the oil spray with the cold iron walls, and a current of highly heated air forced by the piston into the combustion space, giving the heat necessary to ignite the mixture.

The engines without exception are of the explosive type, although the combustion, after the initial high-pressure wave, continues for a brief interval. The engine must be built for maximum pressures as high as the air-injection Diesel, and in some designs the pressures are as high as 650 lb. per sq.in. under normal operation and up to 800 lb. when starting up, unless the engine be equipped with a relief valve.

While the solid-injection engine is simpler than the Diesel and in the smaller powers possesses the advantages of a lower first cost and a probable lower repair cost, it is doubtful if this principle will ever be used in large units. The high compression pressure gives the Diesel a certain advantage. The piston of any engine wears, and as a result the compression decreases and the final temperature is lowered. Since the Diesel can suffer a decrease in the compression pressure of probably 100 lb. before ignition fails, while many solid-injection engines cannot have a loss of over 30 to 50 lb. before firing is irregular, the Diesel can run for a greater length of time before piston renewal is necessary.

To the Man Higher Up

By Lu Edwards

Let me simply herein mention some few facts that claim attention:
Every man who gives full value at the plant
Must spend years in search of knowledge (though he never goes through college),
Yet his stock of brains is anything but scant.
He buys books of information, hopes for fair remuneration,
While he puzzles over problems late at night;
But he boils with indignation and a sense of degradation,
At the premium on ignorance, all right.

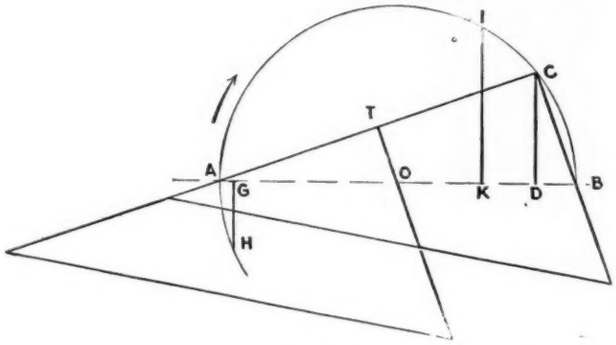
You who hold the reins of power, use your common sense an hour,
Then get busy with a "will" in place of "can't."
For you're making quite a blunder, your equipment's doomed to thunder,
For it's *men*, who give the value, you must grant.
We are human, self-respecting, no known duty we're neglecting,
For we give you faithful service let me say;
But we fear we've missed our calling, as the state of things is galling,
When the man who digs a ditch gets better pay.

Make a visit to your station and behold the situation,
See the men who clean your fires sweat and pant,
Watch the weary, dusky toilers clean your dynamos and boilers,
Key up engines, make repairs about your plant;
For the discontent you're sowing, makes it hard to keep a going,
We are holding on and hoping for fair play.
Give us due consideration and we'll show appreciation,
While we keep the plant a humming night and day.

Easy Solution of Lap Problems

By Robert Grimshaw

To solve the lap problems with the aid of a draftsman's graduated 30-deg. triangle, draw a semicircle with diameter *AB* representing on any convenient scales both the piston stroke and the valve travel. From the desired point of cutoff *D* in piston position (neglecting the influence of connecting-rod length and for the present not considering lead) erect a perpendicular *CD*, cutting the semicircle at *C*. Then *C* is the point in the crankpin path where cutoff occurs. Apply the triangle with its 90-deg. angle at *C*, the short leg passing through *B* and the long one through *A*. Then *BC* will be double the exhaust lap, in proportion to *AB*.



USE OF THE TRIANGLE IN DETERMINING THE EXHAUST LAP

That is, if *AB* is drawn 6 in. (as for valve travel 3 in., piston stroke 24 in.) and *BC* is 2 in., the lap to cutoff at *D* will be 0.5 in.

Another way to get the lap for a given cutoff is to apply a straight-edge to *AC* and slide the triangle along until the short leg cuts the center *O* and the long one runs through *A;* then *OT* will be the lap in proportion to *AB*.

To reverse the process so as to find where a given steam lap will cause cutoff, apply the triangle with its short leg on *B* and its long one on *A* (sticking pins at *A* and *B* is convenient) and slide it about until *BC* equals double the lap on the valve travel scale. Plumb down from *C* to *AB;* the point *D* will be the point of the stroke at which cutoff takes place.

Where there is linear lead expressed in terms of valve travel, and cutoff point is desired, set off a distance *AG* corresponding thereto on the valve-travel scale; draw *GH* perpendicular to *AB;* set off *CI* equal to *GH;* draw *IK* perpendicular to *AB;* cutoff takes place at piston position *K*.

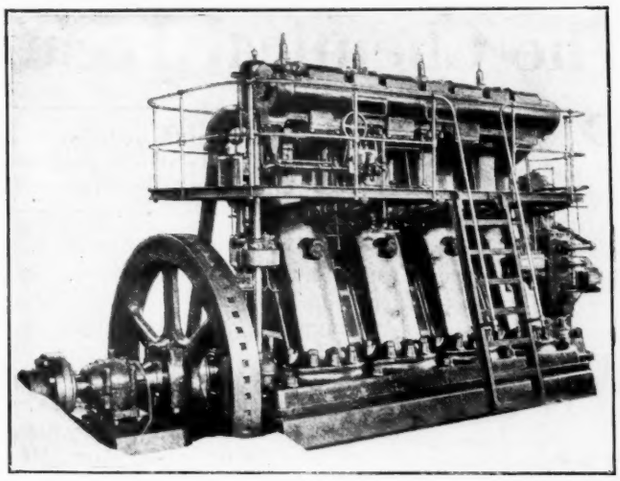
If lead is expressed in piston stroke, set off *AG* on the piston-stroke scale and do as before.

A great deal of benefit has recently been derived from an installation in a turbine plant of a Western industrial concern, whereby the lubricating oil in use in three 1,875-kva. turbo-generators is passed through 100 ft. of 2-in. copper coil, the latter being immersed in circulating cooling water from the ocean. The effect is a decrease in temperature of this oil of 40 deg. F.

A good cement for brass and glass can be made by mixing together two parts litharge, one part white lead, three parts linseed oil and one part gum copal. Use at once.

Testing Lubricating Oils for Internal Combustion Engine Cylinders

By W. F. OSBORNE
Supervisor Manufacturers' Service, Texas Company



THE method to be followed in testing internal-combustion cylinder oils depends a good deal upon what sort of information is desired. To compare the relative suitability of two oils for a power-plant engine, we must test them under identical conditions. The average operating load and speed should be selected, or if the load is variable, the test should be made long enough to average up the loads on both tests. Although it will not be feasible in some instances to secure all the information suggested, a log of such a test should be somewhat as follows:

A. TIME:
1. Time of starting the test.
2. Time of each reading.
3. Time of ending the test.
4. Total number of hours in operation.

B. OIL CONSUMPTION:
1. Gallons of oil put into lubricating system or lubricator at start.
2. Gallons of oil added to system or lubricator during test.
3. Gallons in system or lubricator at end of test.
4. Calculate gallons consumed per brake horsepower per hour or per kilowatt-hour.

C. FUEL CONSUMPTION:
1. Fuel in tank or reservoir at start of test.
2. Fuel added during test (use meters for gas).
3. Fuel in tank or reservoir at end of test.
4. Calculate pounds of liquid fuel or cubic feet of gas brake horsepower per hour or per kilowatt-hour output.

D. LOAD CONDITIONS:
1. Revolutions per minute.
2. Brake horsepower by prony brake or dynamometer at ¼, ½, ¾ and full load.
3. Horsepower by indicator diagrams at loads as in D-2 and also for no load.
4. Calculate mechanical efficiency at various loads and plot curve.
5. Calculate frictional losses at various loads and plot curve.

E. INFLUENCING OPERATING CONDITIONS:
1. Temperature of engine room.
2. Temperature of circulating water to engine.
3. Temperature of circulating water from engine.
4. Gallons of water circulated per hour.
5. Temperature of oil in crankcase (if crankcase oiling is used).
6. Temperature of oil to bearings in case of mechanical lubricator.
7. Temperature of air to cylinder.
8. Temperature of exhaust gas.
9. Time of ignition.
10. Analysis of samples of exhaust gas to determine efficiency of combustion.
11. Analysis of samples of fuel to determine constancy of fuel.

F. CONDITION OF ENGINE AT END OF TEST:
1. Condition of cylinder head, piston, rings and valves, with respect to wear, polish and carbon deposits.
2. Character and amount of carbon deposits.
3. Analysis of crankcase oils to show deterioration of lubricant. (Samples should be taken at intervals during the actual running of the test.)
4. Analysis of new oil for all physical and chemical properties.

If a test is made to compare the lubricating performance of one oil on two or more engines, in addition to the data herein indicated, complete information concerning the mechanical factors influencing lubrication should also be secured. Some of these items are as follows:

1. Cylinder diameter and length.
2. Piston stroke.
3. Piston diameter and length.
4. Area of piston in contact with cylinder wall.
5. Piston clearance. If piston is tapered, the clearance at all points of variation should be ascertained.
6. Number and type of piston rings.
7. Width of piston rings.
8. Piston-ring pressure.
9. Character of piston metal.
10. Diameter and length of all bearings—connecting-rod, wristpin and mainshaft bearings.
11. Bearing clearance.
12. Type of bearing metal.
13. Method of lubrication (full description including lubricators, oil grooves, pipes, leads, pumps, filters, capacity of system, rate of circulation, etc.).
14. Method of fuel admission (carburetor, air injection, solid injection).
15. Method of fuel ignition (spark, hot plate, compression).
16. Type of cycle (two-stroke, four-stroke).
17. Method of cooling engine (air, forced water circulation, siphon, oil, etc.).

There are, in addition, a great many mechanical details of operation which vary with different installations and affect lubrication, which it is not necessary to mention here now. Most of the important items have been outlined, and some of the others that are peculiar to particular installations will quickly be recognized by the engineer who is making the test.

The Chemical Treatment of Feed Water*

AS THE eighth installment in the series on feed-water treatment this article explains the meaning of hardness and shows how it may be eliminated by "lime and soda" treatment.

PERHAPS the most obvious method of purifying boiler-feed water is to add suitable chemical reagents in such quantities as to precipitate practically all of the scale-forming compounds. For this purpose the "lime-and-soda" treatment, in one form or another, has been used for years. Although this method of purifying feed water is more generally known to stationary engineers than the distillation and zeolite processes described earlier in the present series, its practical importance warrants a review of the principles involved. To the housewife hard water is water that forms a lather with difficulty, requiring an excessive amount of soap and then leaves an annoying scum. To the power-plant engineer hardness is a measure of the amount of scale and sludge a given water will deposit in the boilers. The one kind of hardness is the same as the other, because the substances that combine with soap to form a scum are the same as those that cause boiler scale.

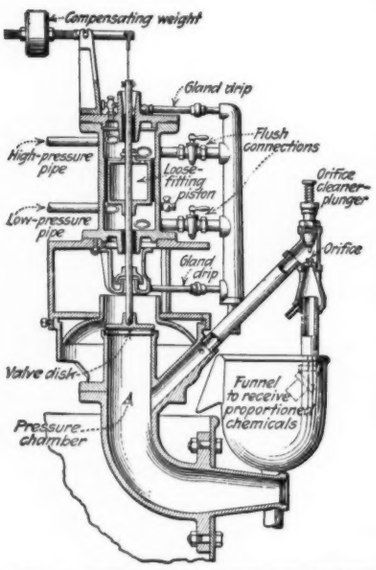


FIG. 1—CHEMICAL PROPORTIONER MAKING USE OF AN ORIFICE AND SPECIAL PRESSURE CONTROL

"Hardness" is frequently classified as "temporary" hardness and "permanent" hardness on the basis of the ease of its removal by heating the water. Suppose that the hardness of a certain water is measured by the amount of standard soap solution required to form a permanent lather. The result obtained is the "total" hardness, the sum of the temporary and the permanent hardness. If, now, a sample of this water is heated to the boiling point, some of the scale-forming compounds are immediately precipitated. The substances precipitated represent the temporary hardness, and what is left is the permanent hardness. The latter can be measured by another test with the standard soap solution. Then the amount of temporary hardness is evidently the difference between the permanent hardness just found and the total hardness as originally measured.

From this explanation it may be seen that the temporary hardness may be largely precipitated in an ordinary open feed-water heater provided it heats the water practically to 212 deg. The permanent hardness, however, enters the boiler and is then thrown down as scale on account of the high concentrations and temperatures. A complete explanation of the chemistry of feed water would be involved and comprehensible only to a trained chemist. The more important facts may, however, be well enough understood by power-plant engineers to permit of intelligent handling of chemical water-softening apparatus. Detailed operating instructions are furnished by the manufacturers of the various types of equipment, so the only purpose of the following explanation is to bring out the high lights of this method of treatment.

Hardness is due, in the main, to compounds of calcium and magnesium. These may occur as bicarbonates, carbonates, sulphates, chlorides, etc. Of all of these compounds practically nothing but the calcium bicarbonate is temporary hardness; the other compounds form the permanent hardness.

Calcium carbonate may be pictured as limestone, marble, or chalk, these being more or less pure forms in which this compound occurs in nature. While the carbonate is to a certain degree soluble in water, it is taken up in large quantities only when the water contains carbon dioxide in solution. This combines with the calcium carbonate to form calcium bicarbonate, which is highly soluble. Heating water drives out the carbon dioxide and turns the bicarbonate back to the relatively insoluble carbonate, most of which precipitates out.

The chemical treatment of temporary hardness also depends upon the removal of the excess carbon dioxide to turn the calcium bicarbonate into the carbonate. This is accomplished by means of milk of lime, which is merely water with an excess of hydrated lime.

In addition to lime, most waters require soda ash (sodium carbonate). Some of the impurities require lime alone, some soda alone and some require both. As the reactions are rather complicated when several impurities are present, the amount of lime and soda required should be determined—after the water has been analyzed—by a chemist familiar with feed-water treatment. The following, however, will serve to give the reader a general idea of the more important reactions.

Magnesium bicarbonate, like calcium carbonate, is treated with lime, but enough must be added to form magnesium hydrate, as magnesium carbonate is so soluble that it will not precipitate out until boiler concentrations are reached.

Calcium sulphate (gypsum) is treated with soda ash. This throws it down as calcium carbonate, leaving sodium sulphate in the feed water. The latter, as is true of all sodium compounds, has no scale-forming properties

Magnesium sulphate is removed by treating with lime and soda, the soda being necessary to change the calcium sulphate which is first formed into calcium carbonate. Similarly, calcium chloride is treated with soda alone, while magnesium chloride requires both lime and soda.

These chlorides of calcium and magnesium, along with dissolved carbon dioxide, greatly accelerate cor-

*The following articles have so far appeared in the series on feed-water treatment: "Softening Boiler Feed Water with Zeolites," Sept. 12, 1922; "Evaporators in the Stationary Power Plant," Sept. 19; "Corrosion—Its Cause and Cure," Oct. 3; "Corrosion—Apparatus to Prevent It—I," Oct. 24; "Corrosion—Apparatus to Prevent It—II," Nov. 7; "How a Lillie Evaporator ates," Nov. 21; "The Flash Evaporator," Nov. 28.

rosion, except where the water is made non-corrosive by the removal of dissolved oxygen by the methods explained in previous articles of this series.[1] Where oxygen is present, the chemical treatment reduces corrosion by removing the chlorides of calcium and magnesium and also by rendering other corrosive agents less effective.

The amount of lime and soda required for proper treatment of a given water is slightly more than that chemically computed to neutralize the scale-forming impurities, because an excess of reagents is necessary for satisfactory precipitation. Accurate control of the amount of chemicals supplied is important. Too little will leave the water still hard, while too much will not only involve waste, but also undesirably raise the total dissolved solids in the feed water, and thus make it necessary to blow down more frequently to prevent priming.

There are two general types of apparatus for the chemical softening of feed water. These are known, respectively, as the "cold" process and the "hot" process. Both are used in power-plant work, the latter being applicable where all the water to be treated is to be used for boiler feed and is to be heated in any case. The same reagents (soda ash and hydrated lime) are used in both cases. The reactions are likewise the same in both cases, but the tank in which the reactions and the settling take place is smaller in the case of the hot softener because reactions and settling are completed in much shorter time at high temperatures. The cold process, on the other hand, permits of somewhat more accurate treatment, since the water may be handled intermittently in batches with individual adjustment of chemicals for each batch.

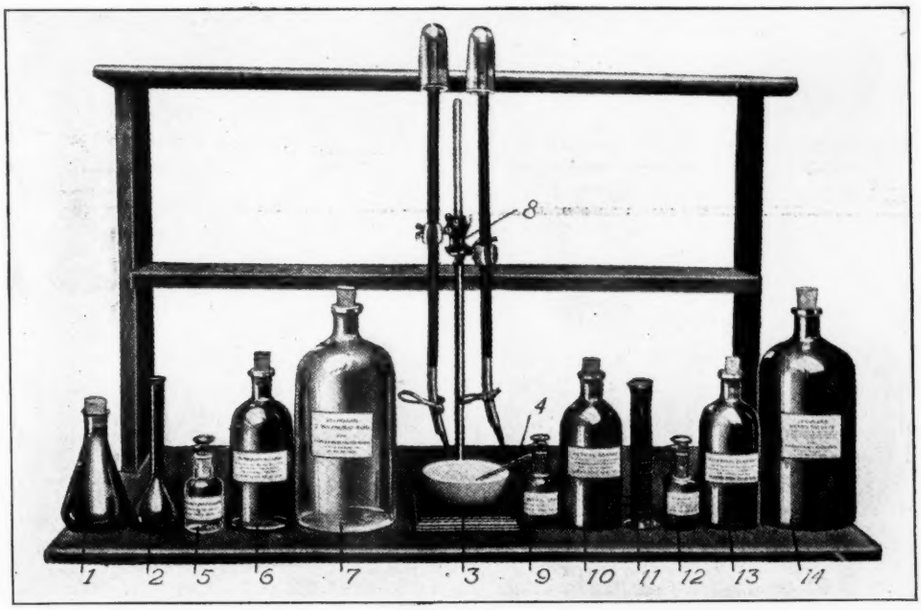
The essential parts of a chemical softener (either "hot" process or "cold") are as follows: Tank for reaction and settling; some means (automatic for continuous systems) of proportioning the chemicals to the amount of water to be treated; a filter to remove any unsettled particles of precipitate before the water passes to the boiler.

Fig. 1 shows the type of chemical proportioner used with the Cochrane hot-process softener. In this a chemical solution, previously made up to a strength suitable for the water being treated, is forced through a small orifice by a pressure that is always equal to the differential pressure on a large orifice through which the main supply of feed water passes. Since the flow through both orifices is determined by the same pressure difference, the amount of chemical solution passing through the small orifice bears a constant relation to the amount of feed water to be treated. The weight of chemicals supplied per pound of feed water may be changed, whenever a change in composition of the feed water requires it, by varying the amounts dissolved in each batch of solution.

To maintain a pressure on the small orifice equal to the pressure drop across the large orifice, pipes connected to the high- and low-pressure sides of the latter are led to the two sides of a loose-fitting counterbalanced piston. Through a valve disk at the lower end of the piston rod this exerts a pressure on the supply of solution exactly equal to the pressure difference across the main orifice. The solution is supplied in excess so that some is always leaking around the disk and passing back to the chemical supply tank.

FIG. 2—APPARATUS FOR TESTING TREATED WATER

1—Sampling flask.
2—Measuring flask.
3—Test cup.
4—Stirring rod.
5—Phenolphthalein (dropper).
6—Phenolphthalein (stock).
7—Standard acid.
8—Burettes.
9—Methyl orange (dropper).
10—Methyl orange (stock).
11—Graduate.
12, 13, 14—Reagents for concentration test.



In order to change the treatment to correspond with gradual variations in the composition of the raw water, it is necessary to make frequent tests of the treated water. Fig. 2 shows the equipment which is supplied for this purpose with the Cochrane softener. The test made is really to determine what are called the "phenolphthalein value" and the "methyl-orange value." Without going into a chemical explanation, it may be said that the measurement of these two quantities shows whether the treatment is correct. If not, the quantities of lime and soda are varied, usually by the method of trial and error, until the results obtained by the test fall within the limits established by the manufacturers of the apparatus for the particular installation.

Without going into all the details of manipulation, the method of making a test is, briefly, as follows: One of the burettes (8) is filled with standard acid solution from (7). The sample of water collected in the flask (1) and measured (100 c. c.) in flask (2), is placed in the cup (3) and colored pink with two drops

[1] See *Power*, Oct. 3, Oct. 24 and Nov. 7, 1922.

of phenolphthalein (5). Then the acid is run in, drop by drop, while stirring the sample, until the color just disappears. The volume of acid used is recorded as the "Ph. value." The water is next colored yellow with two drops of methyl orange (9), and more acid is run in until the color starts to change to orange. The total amount of acid used from the start of the test is recorded as the "M. O. value." The two figures thus obtained, "Ph. value" and "M. O. value," are then compared with the standards set, and changes are made in the treatment where necessary. The second burette (8) and some of the reagents shown but not yet mentioned, are for the silver-nitrate test for concentration. This test is used to regulate the boiler blowdown.

Synchronous Timing Device for Relays

A synchronous timer, Fig. 1, recently developed, has been designed as an accurate method of timing relay operations. The value of relays when used in conjunction with other protective apparatus is often dependent upon the accurate measurement of time intervals required for them to function. This timing device operates on a 50- or 60-cycle 110-volt supply with a permissible voltage variation of 10 per cent.

A synchronous motor operates the clock hands through a gear train, a friction clutch enabling the hands to be started and stopped with the motor running at synchronous speed. The starting and stopping occur within a fraction of a cycle, so that the resultant error is not appreciable. A solenoid-operated plunger normally engages a ratchet wheel and prevents rotation of the clock hands by causing the clutch to slip. When the solenoid is energized, the plunger releases the ratchet, allowing the clutch to hold. The ratchet will permit the hands to be turned back to the stop by means of the reset knob, but will not allow them to be turned forward. The solenoid, with its series resistor, is designed for use on a 110-volt alternating- or direct-current circuit, and the hands may be stopped either by short-circuiting the solenoid (clutch) and leaving the resistor across the line or by opening the solenoid circuit. The dial has a standard clock face with standard ratio clock hands, the large hand making one revolution for every sixty cycles of time, while the small hand moves five small divisions, or one-twelfth of a revolution, in the same time. Obviously, the indicated time in seconds is dependent upon the synchronous motor supply frequency, but in all cases one revolution of the large hand indicates 60 cycles. If the readings are put down in clock time, as 2:20 for two revolutions, twenty cycles, equivalent to 2 seconds and 20 cycles on a 60-cycle system, and later converted into seconds or cycles, they can be taken very rapidly and accurately.

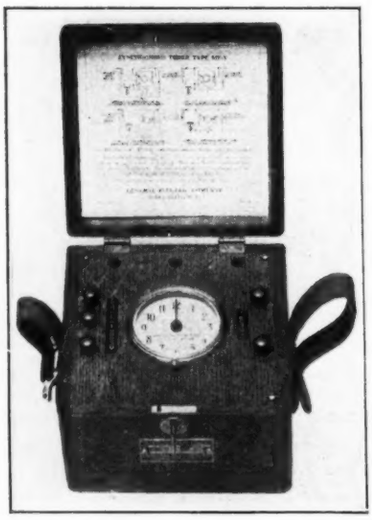
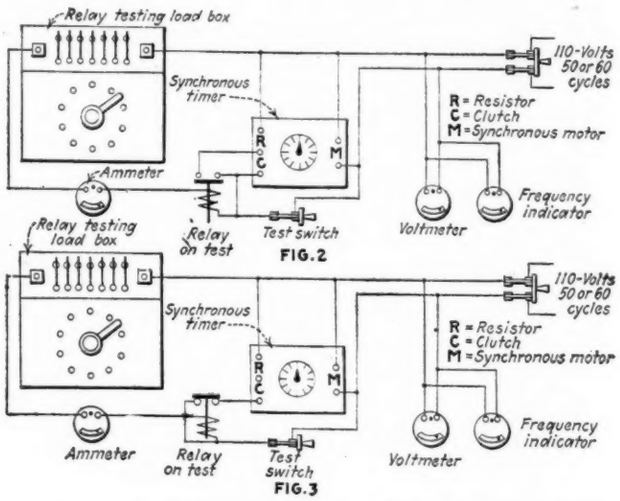


FIG. 1—DEVICE FOR TIMING RELAY OPERATION

In Figs. 2 and 3 are shown connections for making relay tests on 50- or 60-cycle circuits. Fig. 2 is for a circuit-closing current relay. The current is adjusted by the load box, then the test switch is closed, which connects the clutch *C* across the line through resistor *R* and the relay to the line through the load box. This closes the clutch and puts the timer's hands in motion, and at the same time the relay starts to close. When the relay closes, its contacts short-circuit clutch *C* and stop the timer's hands, from which the time required for the relay to operate can be determined.



FIGS. 2 and 3—CONNECTIONS FOR TESTING RELAYS WITH SYNCHRONOUS TIMER

Fig. 2—Connections for testing circuit-closing current relays on 50- or 60-cycle circuits. Fig. 3—Connections for testing circuit-opening current relays on 50 or 60 cycles.

Relays may be connected on separate source from timer for making tests on other frequencies or on direct current. Timer will operate on 50 or 60 cycles with an allowable voltage variation of 10 per cent, but in all cases one revolution of large hand indicates 60 cycles.

Fig. 3 gives the connections for testing a circuit-opening current relay. When the single-pole test switch is closed, the circuit is completed for the clutch through *R* and the relay contacts; at the same time the relay-coil circuit is completed through the load box. When the relay contacts open, they interrupt the clutch circuit and the timer's hands are stopped, thus giving an indication of the time required for the relay to function. From the position of the hands the actual time can be determined as indicated in the foregoing.

It is not necessary to disconnect the timer from the circuit while adjusting the current through the relay, as the timer can be quickly reset to the starting position after the current is adjusted and before the reading is to be taken. The relay may be connected to a source separate from the timer when making tests on different frequencies, direct current, and current or low-voltage relays. In such a case a double-pole switch must be used to close the timer and relay circuits simultaneously. It may also be necessary to connect the timer and the relay to separate sources when checking relay operations where the current used in checking is sufficiently heavy to reduce the line voltage below that necessary to operate the timer. This device has been developed and placed on the market by the General Electric Company.

EDITORIALS

The Power Show

BY THE character of the exhibits, the attendance and the interest shown by the visitors, the Power Show, held last week in New York, has unquestionably established its right to a place on the calendar as an annual event. In fact, the Advisory Committee has already decided to repeat the show in 1923. Furthermore, it is probable that the date may be advanced so as to have it simultaneous with, rather than follow the A.S.M.E. meeting. Notwithstanding that this was its initial appearance, every booth on the main floor of the Grand Central Palace was occupied and exhibitors numbered close to a hundred. The attendance was over forty-seven thousand.

Unlike many other expositions it contained little of a spectacular nature such as would appeal to the general public. Instead, those who visited the show were prompted with a serious purpose; they went there in order to become better informed on power-plant practice and equipment. In fact, a number of the exhibitors reported the actual signing of contracts at their booths.

There was a noticeable absence of prime movers, which was regrettable, especially as the Exposition afforded the engine builders an excellent opportunity to show that they are still very much in the running. The visitor to the show, however, was impressed by the fact that prime movers no longer constitute the major part of the modern power plant, even though they form a necessary part. The decision of the engine and turbine builders was probably due, in part at least, to hesitation in assuming the trouble and expense of shipping and setting up suitable exhibits of this character in connection with an untried venture. The success this year, however, should remove any such doubts another year.

Apportioning Depreciation

THERE was a side line of thought suggested by Colonel Junkersfeld's discussion of Mr. Orrok's paper at the recent meeting of the A.S.M.E.

If it is the purpose of power-plant accounting to apportion the gross cost over a term of years to the periods for the use and benefit of which those costs were incurred, then the cost of a piece of apparatus, a turbo-generator for example, should be charged to each year in proportion to the number of kilowatt-hours generated in that time.

If the total number of kilowatt-hours that the unit would generate during its lifetime were known and its cost allocated to each time period in the proportion of the current generated during that period to the life total, the problem would be solved from this point of view.

The total life's work of the unit is not known and can only be estimated.

It is the history of such units, however, that the bulk of their useful work is done during the first few years of their existence. Then they get outgrown as to capacity or outdone as to efficiency and put upon the side lines as spares, with limited opportunities for service. If the years which profit by the service of this unit are to be charged with their correct proportion of its cost, the unit should be heavily depreciated while it is most actively in service, to the end that while it is serving largely as a spare it shall bear only a largely diminished interest charge and add a diminished quantity to the cost of the current otherwise produced, by its own reduced depreciation.

Economic Sizes

IT WOULD be well if the principle of "economic sizes" were more generally understood and applied by the engineers who determine the selection of new equipment. Take, for example, the question of the proper thickness of pipe covering. Many small plants still continue to use the thinnest commercial insulation in places where covering two inches or even more in thickness would be a better investment. Sometimes, but not often, the reverse condition is found, where excessively thick insulation is used on small or low-pressure steam lines.

In the case of pipe covering the question of "economic size" becomes one of "economic thickness." To find this, it is first necessary to determine the applied cost of the various commercial thicknesses, and to estimate the useful life of the covering. These items, together with a fair rate of interest on the investment, are the data needed to figure the total yearly cost of insulation. The gross yearly savings for various thicknesses can be obtained from available tables if the pipe size, steam temperature and cost of producing steam are known. In this, allowance must be made for the periods during which the piping contains no steam.

Then the net yearly saving for each thickness is the gross saving minus the total yearly cost. The thickness that gives the greatest net saving makes the best investment. Some engineers may say that this is true in theory but not in practice, but there seems to be no good reason why thicknesses figured in this way should not be those actually selected provided that good judgment is used in determining the values of the various factors entering into the computation.

As an example of the use of judgment in connection with the factors, the mere fact that the insulation has an estimated life of twenty years does not necessarily indicate that the capital charges should be figured on a twenty-year basis. Perhaps the installation is temporary and is destined to be dismantled in, say, five years. In that case it is only common sense to figure yearly cost on the basis of the five-year rather than the twenty-year life. In the same way the proper rate of interest to allow is not necessarily that charged by banks for well-secured loans. It may easily happen that the owners can invest at a much higher rate, in which case the higher rate should logically be used in computing the yearly interest charge on the cost of the insulation. If these and other practical considerations are fully considered in determining the factors

used to figure the total yearly cost and the gross yearly saving, it should be possible to accept the final computed result without question.

The same fundamental method of finding the "economic size" can be applied to piping, feed-water heaters, boilers, economizers, engines or any other pieces of power-plant equipment provided it is possible to reduce all the essential factors to a dollars-and-cents basis. Where that cannot be done accurately, the final choice must be determined by "judgment." This, however, is best applied twice—once in estimating values for use in a preliminary computation, and once for checking and modifying the result obtained.

Why Substitute if the Real Thing Can Be Produced?

IT HAS frequently been asserted by the mine operators that the coal shortage is due to the inability of the railroads to provide the necessary transportation facilities. This statement undoubtedly in a large degree represents the facts in the case. However, the grades of coal that were shipped to market during the shortage of 1919 and 1920 and again during the present crisis, would indicate that instead of trying to alleviate the situation by sending to market the grades that are in demand, the operators are taking advantage of the present situation to foist upon the public, coal that in normal times there is little or no market for except at very low prices. The railroads can as easily handle a car of good coal as they can one mined from the culm banks. But the present indications are that the coal markets are glutted with grades that the public do not want and will use only when they must do so to prevent suffering.

Present conditions in the coal markets apparently bear out the charge made recently by C. J. Golden, president, District No. 9, United Mine Workers of America, that the operators are flooding the markets with the steam sizes because of the much larger profit which the sale of these grades nets them. According to Mr. Golden, steam-size anthracite, costing in most cases less than twenty-five cents a ton to produce, is being sold in New York for $8.10 a ton. Proportion of steam size produced now is greater than ever before in the history of the industry and most of it is being washed out of the culm banks where it has been piled as refuse during the past fifty years. While this is being done, hundreds of miners who could be at work producing freshly mined domestic sizes are walking the streets without work. These charges and others more sweeping will be laid by Mr. Golden before President Harding's coal commission when it takes up its study of the anthracite industry in January.

Undoubtedly, Mr. Golden is endeavoring to make his case as strong as possible, but there are many indications in the present coal situation that tend to substantiate his charges. According to reports coming from the New York fuel administrator's office, there were on Dec. 11 over thirty thousand tons of buckwheat coal standing on loaded cars at tidewater points in and around New York City, and it was estimated that about one hundred thousand tons of the same grade of fuel was on boats in the harbor awaiting a market, some of this coal having been in this port since last September.

If the mines can produce more coal than the railroads can transport, then why is the market flooded with substitutes for domestic sizes? These substitutes have less heat value and cannot be used as economically as the more marketable grade, so that their shipment not only ties up equipment that could be used for the better grades, but for every ton transported the percentage of waste that must be hauled is greater. Therefore, instead of alleviating the situation, these substitutes are making it more acute. As long as the coal markets are flooded with grades for which there is no demand, it will be difficult to understand why the present coal crisis is due to a car shortage other than one artificially created to force upon the public at an exorbitant price something that they do not want. The present situation once again emphasizes the necessity of governmental regulation all the way from the mine to the consumer before the coal problem can ever be solved effectively and permanently.

Are Instruments Truthful?

OCCASIONALLY, we run across an odd piece of humanity who, so his knowing neighbors declare, would rather lie than tell the truth. One cannot feel indignant even though the victim of the liar's activities, for there is a feeling that mentally the character is irresponsible and is as much a victim as anyone. Nevertheless, we deplore the existence of such a propensity on the part of any human.

How much worse are conditions when engineers are willing to go along day by day reading instruments that have no choice but to lie!

Why should engineers talk and record in terms of gage pressure when in fact this pressure is never the same in any two places? Why not speak in terms of absolute pressure? Every day there is confusion and at times trouble as a result of men thinking thirty pound gage is twice fifteen pound gage.

Again, why should we speak in terms of inches of vacuum and be satisfied to read an instrument having this scale. In fact, we are in this case making use of a standard of comparison, which standard exists only at sea level. Why not say that the absolute pressure at the turbine exhaust is one pound instead of so many inches of vacuum, for the same vacuum, when obtained in two plants or in one plant on different days, does not at all represent the same pressure conditions.

How many can offhand state the relative actual value of twenty-six and twenty-seven inch vacuum from a pressure viewpoint, or the comparative merit of twenty-six inches at an elevation of one thousand feet and twenty-eight inches at tidewater? Even in the same plant the comparison cannot be made without consulting a barometer and making a correction for temperature.

In case of Diesel-engine air compressors and carbon-dioxide refrigerating machines the gages are usually marked in atmospheres. But when the gage shows one atmosphere, in many instruments the internal pressure is actually two atmospheres, and what is an atmosphere any way? The engineer at Denver does not agree with the man at Boston.

Even in case of thermometers it might be advantageous to have the divisions marked as units of absolute temperature, although not to the same extent as in case of pressure gages.

It seems that engineers should insist that some proper standard be adopted so that instruments will be allowed to tell the truth.

PRACTICAL IDEAS from PRACTICAL MEN

What Is the Best Method of Erecting a Steel Stack?

I should like to have some practical suggestions from readers of *Power* who have had experience in the erection of steel stacks, as to the best method of putting up a 3½x65-ft. stack on a base 11½ ft. above the ground; also, how many guy-wires are necessary and at what point along the stack should they be fastened?

Vineyard Haven, Mass. THOMAS J. RABBITT.

Blown Fuse Caused Lamps to Burn Dimly

An underground cable carrying three-wire three-phase 50-cycle 2,220-volt current is used to supply three groups of buildings. Cutouts and fuses in each of the three conductors are located in the substation. About 500 ft. from the substation the cable terminates in a junction box from which power is distributed to the different building groups, one phase to each group, duplex lead-covered cable being used between the junction box and the transformer vaults of the various groups. The telephone switchboard, located in one of the buildings supplied by one phase, uses a frequency converter for ringing.

One morning the telephone operator complained that the frequency converter would not work when the lamp, used to illuminate the board, was burning. Upon investigation this was found to be the case. It was also noted that when several lights were turned on the voltage seemed to be very low; in fact, with three or four lamps on, the filaments would barely glow and with another circuit turned on no light could be seen. The building was wired single-phase three-wire 110 and 220 volts, and it was at first thought that a poor contact or a combination of grounds might be causing the trouble, so considerable time was spent going over the system without results.

Finally, the 2,200-volt fuses in the substation were examined and one was found to be blown. A new fuse put the system back to normal. The fact that there was potential on the line had caused the electrician to believe that the 2,200-volt fuses were in good condition.

An explanation of how the potential was obtained on the lighting circuit when the fuse was blown should be of interest. Assume that fuse *B* in the figure was blown. This would not interfere with the operation of transformer *C*, since this unit is connected across the two outside legs of the three-phase circuit. Blowing of fuse *B* makes busbar *B* dead, to which one lead of both transformers *A* and *B* connects. However, this does not make the two transformers dead, but connects their primaries in series across busbars *A* and *C*. The circuit for the two windings in series is from busbar *A* through transformer *B* back to busbar *B*, then through transformer *A* and to busbar *C*. From this it is evident that with the secondary open on transformers *A* and *B* each primary winding will be subjected to one-half the voltage between busbars *A* and *C*. If the load is greater on the secondary of *A* than on *B*, transformer *B* will

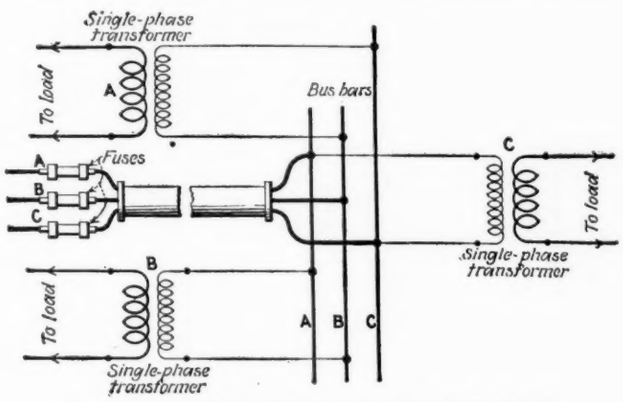


DIAGRAM OF FEEDER AND OF SINGLE-PHASE TRANSFORMER CONNECTIONS

have the highest voltage. On the other hand, if the greatest load is on *B*, transformer *A* will have the highest secondary voltage. This is caused by the transformer supplying the greatest load requiring a greater current through its primary winding than the unit with the smallest load. When more current is caused to flow through the primary winding than that corresponding to the secondary load, the magnetic-flux in the core is increased and with it the secondary voltage and the counter-voltage in the primary. The extreme case of this would be to short-circuit the secondary of one transformer and connect a voltmeter across the secondary of the other, in which case it would be found that the instrument would read approximately normal volts.

Norwalk, Calif. A. C. MCHUGH.

What Is Wrong with These Compressor Diagrams?

The diagrams shown herewith were obtained from an air compressor while operating under normal conditions.

The compressor is a direct-connected steam-driven unit with a 24-in. stroke and 25$\frac{13}{16}$-in. bore. The suction valves are mechanically operated, double ported, Corliss.

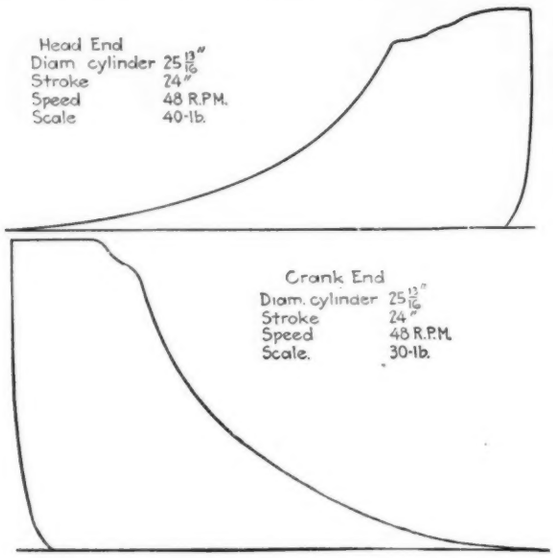


DIAGRAM SHOWS EFFECT OF BYPASS PORTS

The suction supply is taken from a kiln in which air is admitted at the bottom and mixes with gas given off by burning limestone. The gas passes from the kiln through a scrubbing tank and thence to the compressor. The suction line is 8 in. in diameter and approximately 150 ft. long, while the discharge line is 6 in. in diameter and about 100 ft. in length, and discharges into the bottom of a tank containing a heavy liquid, each end discharging into a separate tank.

I should like to have some reader of *Power* who has had experience with this type of compressor criticize these diagrams and tell me if they indicate good operating condition or wherein they could be improved.

Milwaukee, Wis. RUDOLPH WELLANER.

Why Does a High Steam Pressure Produce a Click?

We recently installed an 18 x 30-in. Corliss engine direct-connected to an alternating-current generator and running at 150 r.p.m. From the start there has been a clicking sound in the head end of the cylinder, and we are unable to find the cause for it. We have taken indicator diagrams at different loads, but they do not show any unusual condition. The steam pressure at the engine is 130 lb. gage. If the pressure drops a few pounds, the clicking sound stops, but recurs with the rise in pressure. Conditions in the plant are such that we cannot operate on less than 130 lb., so we are anxious to eliminate the click as it can be heard some distance away from the engine.

Possibly some reader of *Power* has had a similar experience and can advise me as to the probable cause of the noise. J. A. WATT.

Pittsburgh, Pa.

Ground on Control Circuit Caused Oil Switch to Open

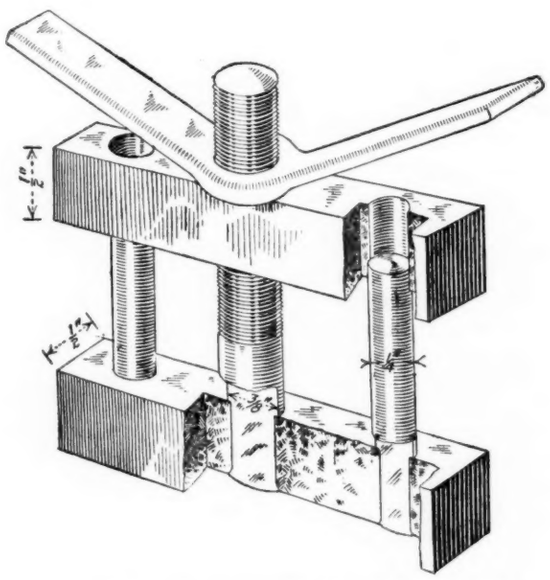
In a certain power station the operator was somewhat puzzled to observe a generator oil switch open without any apparent cause. After an inspection failed to disclose any defect in the switch, the generator was paralleled, and the cause of the opening remained a mystery until a workman reported that he had accidentally grounded a direct-current circuit in a near-by cottage where he was installing a water heater. No ground lamps were used in this station, and the control bus was connected to the exciter bus. A test indicated that the control wiring was grounded at a point where the occurrence of a ground at the water heater completed a circuit which energized the oil-switch trip coil through the ground.

As a general thing control circuits should never be connected to the excitation system, because the opportunities for trouble are greatly multiplied. It is equally important that circuits connected to the conrol bus should never be used except for control purposes, and if extending outside the station, as to outdoor switches, such control circuits should be exceptionally well insulated, and ground lamps are indispensable.

Belden, Calif. RALPH BROWN.

A Handy Cable Clamp

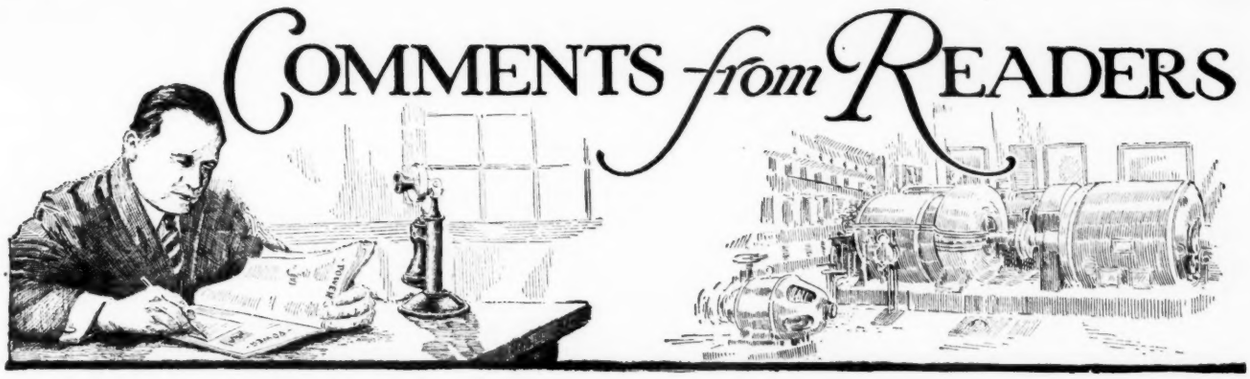
When installing cables on elevators, particularly those of the traction type, it is frequently necessary to clamp one cable to another temporarily. With clamps of the ordinary type a wrench is necessary to tighten them



SHOWS CONSTRUCTION OF CABLE CLAMP

to where they will hold. This requires considerable time and is a somewhat tedious process. The clamp shown in the figure is a home-made affair that can easily be constructed by any mechanic. This clamp can be made tight enough by hand to hold one cable to another, to prevent its falling down the shaft. The device can be applied and removed quickly and will prove a time saver when making cable installations.

New York City. CHARLES A. ARMSTRONG.



Electric Boilers for Heating

With reference to the article on the new type of electric steam generator, by E. M. Horstkotte, and to the editorial in the Nov. 21 issue, ordinarily, one would not think of using electricity for house heating in competition with coal on account of cost. However, in certain localities where coal is expensive and hydro-electric current cheap, it is possible to save money by heating with electricity. In fact, this is being done in some Ontario towns served by the Hydro-Electric Commission. Wherever coal costs about twenty dollars a ton and electricity can be had at one-half cent per kilowatt-hour or less, it will pay to use electricity for heating buildings.

Electricity can be used for house heating in many more localities in this country than is now generally assumed, and the present high price of coal should encourage this more extended use of hydro-electric service. This method of heating is employed very widely in some European countries, and a study of their methods indicates possible applications here.

Both electric steam boilers and electric hot-water heaters are being used abroad for this purpose. Briefly, the steam system consists of an electric boiler and several large cylindrical drums which act as steam receivers and which can withstand high pressure. The whole installation is heavily lagged to keep radiation losses at a minimum. The current is only used during off-peak hours when, if there is no water storage, available hydro power would go to waste. The current is switched on by a time switch and off by the same switch or by a pressure or temperature relay. While the current is on, steam is generated at a rapid rate at increasing pressures until the drums are filled with high-pressure steam to their rated capacity. High-pressure steam contains the greatest amount of heat in a given volume and forms a desirable means of storage. During the day this steam is drawn off into the heating system through reducing valves and serves to heat the building, the condensate returning to the receiver that feeds the electric boiler. The amount of connected heating service fixes the size of the receivers and of the electric boiler. The system can be tied in with the present installation, and the coal-fired boilers can be held for emergencies. The electric boiler is said to require little attention or maintenance.

One of the objections to the steam system is the expensive construction for high steam pressures. When it is desired to operate at low pressure, the hot-water system is used. It consists of a number of large, heavily insulated hot-water storage tanks. During the off-peak hours all the water in these receivers is warmed up to the boiling point by electric heaters. It is best to connect these storage tanks one after the other to the house-heating system during the remainder of the day in order to maintain even temperatures in the building.

These systems are said to take little attention. There is no dirt from coal, ash or smoke around the buildings and no labor for firing. It can be seen that this will provide very cheap heating where power is paid for at a fixed rate per kilowatt-year and where there is no water storage at the hydro-electric plant. There are several localities around the country where this use of off-peak flow might be developed with profit to both the electricity producer and the user. A. G. CHRISTIE.

Baltimore, Md.

Power Cost for Electric Steam Generators

Mr. Horstkotte's article on "New Type of Electric Steam Generator," in the Nov. 21 issue, is very interesting, but the figure of approximately one kilowatt-hour for every three pounds of steam generated, does not seem to be reasonable.

On this basis consider the cost of generating 10,350 lb. of steam from and at 212 deg., as compared with an ordinary hand-fired boiler using coal. The total water to be evaporated from and at 212 deg. F. is 10,350 lb., which would require a power consumption of 3,450 kw. With power at 1¾c. per kw.-hr. the cost of power for operating the boiler would be $60.37 per hour. The total heat necessary to generate 10,350 lb. of steam from and at 212 deg. F., is 10,043,700 B.t.u., which is equivalent to a coal consumption of 0.645 tons per hour, assuming the coal to contain 13,000 B.t.u. and the boiler to be operating at 60 per cent efficiency. With coal at $7.50 per ton, delivered to the furnace, the cost of fuel for operating at capacity would be $4.85 per hour. At this rate it would cost a little more than twelve times as much for energy alone to operate the electric steam generator as the ordinary coal-fired boiler. THOMAS G. RALPH.

Marysville, Mich.

[It must be agreed that where power costs 1.75c. per kw.-hr., the electric boiler makes a rather poor showing when compared with the coal-fired boiler. However, when power cost reaches this figure, the electric boiler is practically impossible from an economic viewpoint and is not intended for any such conditions. Where power is purchased from a hydro-electric plant on a horsepower or kilowatt-year basis, the electric boiler may be used economically to absorb the excess energy when the normal load falls below the contract value. In localities near large hydro-electric developments it is possible to purchase power for $20 per kw.-yr. or

less. On a basis of continuous use, $20 per year power is equivalent to about 0.25c. per kw.-hr., which reduces the cost of power for Mr. Ralph's steam to one-seventh of the cost he estimated, or 60.37 ÷ 7 = $8.62. In the Province of Quebec, where about 60 per cent of the important electric-steam boiler installations in North America are made, the cost of coal will be nearer $15 than $7.50, so that the cost of coal for Mr. Ralph's station will be about $9.70 and not $4.85. To this must be added the operating costs, which are comparatively high for the coal-fired plant and low for the electric equipment. Then again, the overhead charges will be lower for the electric boiler. On the basis of three pounds of steam per kilowatt-hour it is approximately equivalent to converting 100 deg. F. water into saturated steam at 100 lb. Other places where electric steam boilers may be used economically are where hydro-electric plants have an excess of energy at certain periods of the year or where water-storage capacity is not available during the offpeak periods. The water under these conditions may be converted into electric energy and utilized economically in electric steam boilers.—EDITOR.]

Auxiliary Ports in Unaflow Engines

As chief engineer of the Skinner Engine Co., I originally checked Mr. Skinner's figures on the relative amounts of exhaust steam issuing from the central and auxiliary exhaust ports of unaflow engines, as tabulated in his article, published in the Aug. 29, 1922, issue of *Power*, and which was criticized by John M. Cassiday in the issue of Sept. 12.

When Mr. Skinner's article was in the course of preparation, it was realized that the points cited by Mr. Cassiday might be raised and that this could be anticipated by a more technical discussion. A discussion of minor details would only detract from the main point at issue; namely, that under ordinary load conditions more exhaust steam does issue from the so-called auxiliary ports than from the central exhaust ports.

Mr. Cassiday's discussion is not a correction of the calculation presented by Mr. Skinner, for the reason that his deductions are based on assumptions which are not true of the unaflow engine. Were his assumptions correct, the remarkable economy and low steam consumption of the unaflow engine could not be obtained, nor would the economy of the unaflow engine equipped with properly located auxiliary exhaust ports be much superior to the unaflow type without auxiliary exhaust ports. Mr. Skinner's demonstration was purposely made as simple as possible so that it could be easily understood by the lay reader. That the correction for the omission of consideration of moisture in the steam is very small is demonstrated by the following facts, which are characteristic of the unaflow engine.

Mr. Cassiday has assumed that directly after the release instant the moisture on the cylinder walls is instantaneously re-evaporated and passes out through the central exhaust ports. One of the most essential considerations in the construction of a high-economy unaflow engine is the use of steam-heated heads and cylinder jackets extending from either end to the cutoff point on the cylinder. The purpose of these jackets is to keep the cylinder walls heated. In classical tests made as early as 1912 in the Technische Hochschule in Dresden, Germany, by Dr. Mollier and Professor Nagle, where very sensitive electric thermocouples were located at different points on the cylinder, it was found that the temperature of the cylinder walls at any point on the stroke was higher than that of saturated steam at the pressure represented on the indicator diagram for that particular position of the piston, and also that the steam of compression on the return stroke was actually superheated to temperatures higher than that of the initial steam being supplied to the engine.

It is therefore obvious that any condensation resulting from adiabatic expansion or inefficiency of the Rankine cycle cannot deposit on the cylinder walls, as their action is to re-evaporate immediately such moisture regardless of the pressure in the cylinder. Any moisture present in the steam at the time of release or uncovering of the central exhaust ports must be held in suspension, because the moisture coming in contact with the cylinder walls is immediately re-evaporated. Any small change in pressure, such as exists at release, does not make possible the instantaneous re-evaporation of moisture in quantities such as assumed in Mr. Cassiday's deduction. This can be easily demonstrated by a simple comparison of the B.t.u. required for evapora-

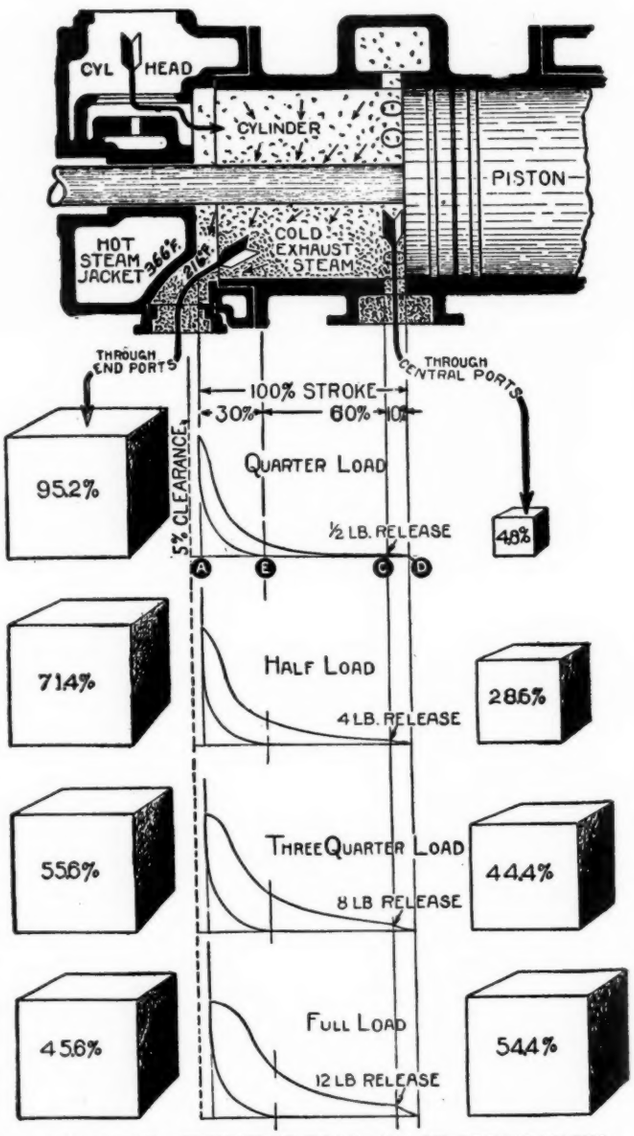


FIG. 1—MR. SKINNER'S DIAGRAM OF STEAM FLOW THROUGH AUXILIARY EXHAUST VALVE

tion and the B.t.u. available by reason of the pressure difference between release and exhaust.

Furthermore, the auxiliary exhaust valve must begin to open immediately after the release instant and, therefore, has considerable opening before the central exhaust ports are again covered by the piston so that steam flows simultaneously through both sets of ports. Therefore any moisture that might be re-evaporated by a slight change in pressure, would pass through the auxiliary port as well as the central port. In fact, moisture in the cylinder at the release instant is more likely to be evaporated near the hot end of the cylinder than near the cold end, which results in a greater weight of steam passing through the auxiliary port.

The particular quarter-load card shown in Mr. Skinner's diagram indicates one-half pound pressure in the cylinder at release, which is a very small pressure to measure on the ordinary indicator diagram. We have many engines on the indicator diagrams of which the expansion line at quarter load reaches the exhaust pressure before the instant of release, particularly if the full-load m.e.p. is rated for best economy. In such cases the pressure difference between the cylinder and exhaust pipe is zero, so that there is no flow of steam through the center ports, but 100 per cent through the auxiliary port. With these engines at loads slightly smaller the diagram shows a vacuum in the cylinder before release and steam actually flows from the exhaust pipe into the cylinder through the central ports at the release point and exhausts more than 100 per cent through the auxiliary ports.

The inconsistency of Mr. Cassiday's assumption is graphically shown in Fig. 2. The vertical ordinates represent load from zero to full load and the horizontal abscissas represent per cent of steam passing through the central ports. The upper curve is plotted through the points arrived at from Mr. Skinner's calculation and shows a smooth and gradual change from a load slightly less than one-quarter to full load. The lower curve is drawn through points arrived at from Mr. Cassiday's calculations. Inasmuch as at slightly less than one-quarter load (at which the expansion line reaches exhaust pressure at release) there can be no flow through the central ports, the curves at this point of course must intersect, as the flow through the central ports is zero. This illustrates the sharp change necessary in Mr. Cassiday's curve, which is not logical and which shows the error of his assumptions.

Mr. Cassiday's conclusion that a four-valve engine with steam-heated heads and using superheated steam is almost as economical as a unaflow engine operating under the same condition is a contradiction to his calculation, because with saturated steam there is a wide difference between the economy of a four-valve engine and a unaflow engine, which shows that the gain in using superheat is much greater with the four-valve engine. In other words, the unaflow accomplishes, without the use of superheat and with correspondingly low steam rates, what the four-valve can accomplish only with the use of sufficient superheat in the initial steam to produce dry exhaust.

That moisture actually does issue from the auxiliary exhaust ports, which is in contradiction to Mr. Cassiday's assumption, is an absolute fact because we found it necessary to change the design of the auxiliary exhaust-valve mechanism on the early Skinner unaflow engines to prevent this moisture from leaking in considerable quantities past the valve stem when the valve was open, and into the oil filled cam box underneath. If no moisture issued from the auxiliary exhaust ports, this change would not have been necessary. On engines running with small back pressure instead of with atmospheric exhaust, an increase of moisture at this point was noted.

Therefore, the location of the auxiliary exhaust ports has a very great effect upon the steam rates, for the reason that if these ports are placed at the ends of

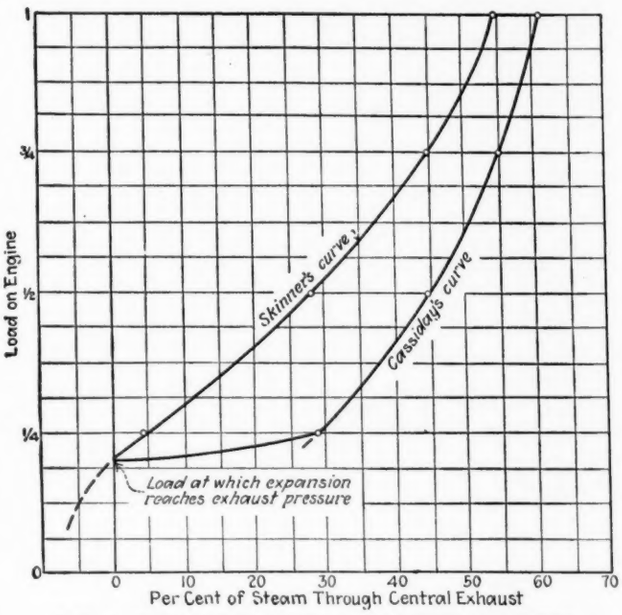


FIG. 2—STEAM FLOW THROUGH CENTRAL PORTS

the cylinder, as in many designs, this moisture wipes and cools that portion of the cylinder which must remain hot for good economy.

As stated before, Mr. Skinner's demonstration was made as simple as possible, and the foregoing reasons indicate that the omission of the moisture consideration does not make any material change in the proportion of steam or water passing through either set of ports. A calculation which would include this consideration or which attempted to arrive at a degree of correctness in harmony with such a consideration must necessarily also include the possibilities of valve leakage, the percentages of cylinder clearance and clearance surfaces, the reheating value of the steam-heated heads and cylinder jackets and the temperatures of the piston faces. Suffice it to say, however, that the demonstration as originally made is simple and accurate enough for the purpose intended and would not be materially changed by any consideration of these modifications.

Erie, Pa. H. G. MUELLER.

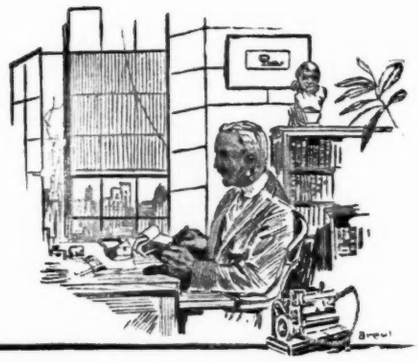
Building Up Worn Valve Rod with Babbitt

In the Dec. 5 issue W. A. Ford describes a method of building up a worn valve rod with babbitt and speaks of peening the babbitt after cooling.

In my opinion peening is neither necessary nor desirable for a job of this kind, as it would tend to expand the babbitt and loosen it on the rod. The natural contraction of the babbitt in cooling should cause it to grip the rod. Peening after cooling is necessary in bearings to cause the babbitt to expand and fill the iron shell. M. A. ANDERSON.

Pittsburgh, Pa.

QUESTIONS AND ANSWERS



Use of Zinc in Boilers

Are zinc slabs placed within a boiler beneficial in prevention of corrosion and, when used, what should be the size of the slabs and method of application? J. E. S.

Zinc does not prevent corrosion in all cases and may even aggravate the trouble, depending on the character of the feed water. When used, its influence should be observed at frequent intervals. In application it is considered that one square inch of zinc surface is sufficient for every 50 lb. of water in the boiler and that there should be electrical connection between the metallic surfaces of the zinc and the boiler, with the slabs suspended in the water of the boiler.

Speed of an Induction Motor

Can a 220-volt 5-hp. 60-cycle induction motor be operated at 1,500 or 2,500 r.p.m.? V. K. S.

A 220-volt 5-hp. 60-cycle induction motor cannot be changed to operate at 2,500 r.p.m. The speed of an induction motor is fixed by the frequency of the circuit and the number of poles in the motor. The speed of the motor is equal to 120 times the frequency (cycles per second) divided by the number of poles. On 60 cycles, a two-pole motor will run at $120 \times 60 \div 2 =$ 3,600 r.p.m. A four-pole motor would operate at half this speed, or 1,800 revolutions per minute, and a six-pole motor at one-third this speed or 1,200 r.p.m. From this it will be seen that the three highest speeds that the motor can operate at are 1,200, 1,800 and 3,600 r.p.m. Of course these are theoretical values, and the actual speed will be about 5 per cent less than the theoretical.

Measurement of Theoretical Height of Barometric Condenser

On a barometric condenser, between what points is the theoretical 34 ft. of height taken? E. R. L.

If the condenser were in regular operation with a perfect vacuum of 30 in., the pressure of the atmosphere acting on the surface of the water in the hotwell would not support a column of water over 34 ft. high above the water of the hotwell. Hence this actual theoretical height would be taken from the surface level of the hotwell water up to the lowest level at which backed-up discharge water could spill over into the exhaust pipe. But to guard against the condensing water flooding over into the exhaust pipe in case the water is temporarily supplied faster than it can be carried off through the throat of the condenser, or a reduction of the density of the discharge pipe column of water by presence of air, especially upon starting the condenser, the 34-ft. level usually is measured from the highest possible level of water in the hotwell up to the exhaust pipe connection. On a barometric condenser this upper limit of the measurement usually is taken at the face of the horizontal flange for connecting the condenser head with the gooseneck from the exhaust pipe.

Steam Correction of Thermometer Readings

Is it necessary to make correction of readings of graduated stem thermometers to compensate the difference of expansion of glass and mercury? R. H. L.

No such correction is necessary with high-grade thermometers having graduations on their stems, when provided with a distinct mark between the bulb and the lowest graduation to indicate the depth to which the bulb end of the thermometer is to be immersed in an oil or mercury bath, or liquid whose temperature is to be taken. When thus immersed, the error due to difference of temperature of the mercury bulb and the thermometer stem can be neglected in engineering work, from the fact that thermometers generally are used to measure temperature differences, and also because the manufacturers' test points on the scale are established under nearly the same conditions of stem temperature as the stem temperatures likely to exist in use of the instruments; hence errors due to variation from conditions of calibration are well within the probable personal error of the observer of the readings.

Equalizing Cutoffs of Riding Cutoff Valve

On a riding cutoff engine with throttling governor, if the cutoff is 3 in. on the crank end and 4 in. on the head end, how can the same cutoff be obtained for both ends without changing the cutoff on the head end? T. E. M.

If there are two cutoff valves movable along on the valve stem, then the valve on the crank end can be moved to a position where it is closed when the piston is at 4 in. of the stroke. When cutoff occurs at the outside edge, lengthening the cutoff on the crank end would be obtained by moving the crank-end cutoff valve nearer to the head-end cutoff valve; but when cutoff occurs at the inside edge of the cutoff valves, the crank-end cutoff would be lengthened by moving the valve along the spindle to bring it nearer the head-end valve. If the distance between the cutoff edges of the cutoff valve is fixed on the cutoff valve stem, then lengthen or shorten the valve stem so as to obtain cutoff at the same length of stroke of the piston from both ends of the cylinder, and reset the cutoff eccentric so as to obtain cutoff at 4 in. stroke of piston from both ends of the cylinder.

Allowance for Quality of Steam

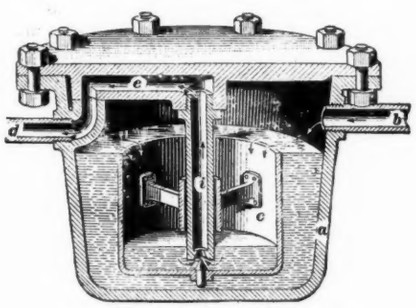
In computing the dry steam or heat consumption of an engine, what allowance is to be made for the quality of the steam? J. F. G.

In engine performances, a moderate amount of moisture present, such as 4 per cent, is considered as neither beneficial nor detrimental to the utilization of the actual dry steam that is supplied. Hence, in estimating the steam consumption, the quantity of dry steam consumed is determined by deducting the moisture found by calorimeter test, from the total amount of feed water (the latter being corrected for leakages and other losses); or in case of a condensing engine, deducting the moisture from the amount of pump discharge. On the other hand, in estimating steam consumption when the steam supplied is superheated, no correction is to be made for the superheat. In estimating heat consumption, the heat content of the dry saturated steam used or of superheated steam supplied, is to be charged against the engine, less the heat that would be contained in the water at the temperature corresponding to the pressure in the exhaust pipe near the engine.

Operation of Bucket Trap

What is the method of operation of a bucket discharge trap? G. H. N.

A sectional view of one of the commonest forms of bucket trap is shown in the illustration. The water of condensation that is to be relieved from a steam pipe or heating system, is received through the pipe *b* into the trap body *a*. As the water rises in *a*, it floats the empty bucket *c*. The discharge valve, shown in the center of the bucket bottom, then closes the opening in the lower end of the stationary central tube *i*, which at its upper end is in communication with the passage *e* and discharge outlet *d*. Hence, whenever there is sufficient weight of water in the bucket to overcome the buoyancy, the discharge valve opens and, with sufficient



BUCKET DISCHARGE TRAP

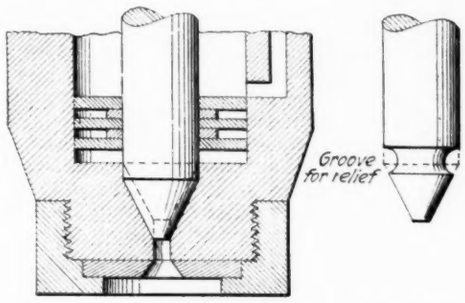
pressure entering at *b*, water in the bucket is discharged up through the tube *i*, the passage *e* and then through the outlet pipe *b*.

When first put into service, steam blows through the trap until sufficient condensate has accumulated in the body *a* to float the bucket and close the outlet valve. As the water continues to rise in *a*, it finally overflows into the bucket until the combined weight of the bucket and contained water is sufficient to cause the bucket to drop. The valve then is opened as shown in the figure, and discharge takes place as previously described. When the trap "blows," vaporization of the hot water discharged sometimes is mistaken for leakage of steam through the discharge valve.

Diesel Spray Valve Does Not Work Properly

We have a 300-hp. Diesel engine that has been in service for several years, but found it was necessary, owing to dirty fuel oil, to regrind the fuel spray valves every three weeks and to re-ream the seats about once in three months. The engine's power has steadily decreased and, since the last re-reaming, will not carry over half load. What is the trouble? W. L. B.

In regrinding and re-reaming the spray valve, the needle has been lowered more and more into the bottom



IMPERFECT AND REPAIRED NEEDLE VALVE

end of the valve cage. Its original position is shown in dotted outline in the illustration. The result has been that the passage for the fuel between the valve tip and seat has been steadily decreasing. The last re-reaming probably lowered the needle so far that the shank of the needle enters the bore of the cage so much that when the needle is lifted the shank does not rise above the bore. Consequently, none or little oil can pass between the shank and cage bore.

Spray valves should not be re-reamed too often. In most cases a little grinding will suffice. As a remedy you might place a groove in the needle so that there is not a complete stoppage of the oil around the needle shank, as shown in the figure.

Boiler and Chimney for Heating Plant

What rule can be followed for the size of boiler and for the size of chimney 60 to 80 ft. high for a steam-heating plant containing about 14,000 sq.ft. of direct radiating surface? E. M. S.

A safe rule to follow is to allow one square foot of boiler-heating surface to 10 sq.ft. of radiating surface, from which 14,000 sq.ft. of radiation would require 1,400 sq.ft. of boiler-heating surface. For a chimney 60 ft. high, allow $\frac{3}{4}$ sq.in. of cross-sectional area of flue to 1 sq.ft. of boiler-heating surface. For 1,400 sq.ft. of boiler-heating surface the smallest cross-sectional area of the flue should be $1{,}400 \times \frac{3}{4} = 1{,}050$ sq.in., and a square flue should be $\sqrt{1{,}5050} = 32$ in. $\times$ 32 in. As the draft power is directly as the square root of the height, the required cross-sectional area of chimney flue, if 80 ft. high, would be

$$1{,}050 \times \sqrt{60} \div \sqrt{80} = 1{,}050 \times 7.746 \div 8.944 = 909.35 \text{ sq.in.}$$

or $\sqrt{909.35} = 30$ in. $\times$ 30 in. at the smallest part of a square flue.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Ash Handling*

By JOHN HUNTER and ALFRED COTTON

THE greater part of this paper deals with stationary practice, beginning with rudimentary installations and progressing to the most modern, of which many actual examples are given. Methods of handling ash on shipboard are first described, as it was here that ash-removal apparatus was originally employed.

In marine practice conditions are nearly alike in all installations since "a ship is a ship," placing definite limits on furnace conditions, distance and direction to point of ejection and providing an inexhaustible medium for ash disposal. In land practice, however, each element in the chain presents different characteristics in different installations, giving rise to a great variety of method and equipment.

One of the best-known examples of ash ejectors discharging the ashes below the ship's water line is known as Stone's Underline Ash Expeller. This utilizes the water-injector principle characteristic of locomotive steam boilers; steam produces a water jet that has sufficient velocity to discharge against the pressure of the water under the ship. Ashes are mixed with this jet and are thus carried over board. This also has the advantage of discharging wet ashes so that a trail is not left on the surface, which would be objectionable to warships. As each ejector can discharge a large quantity of water per hour, it may be also used as a salvage pump when serious leakage occurs; the British

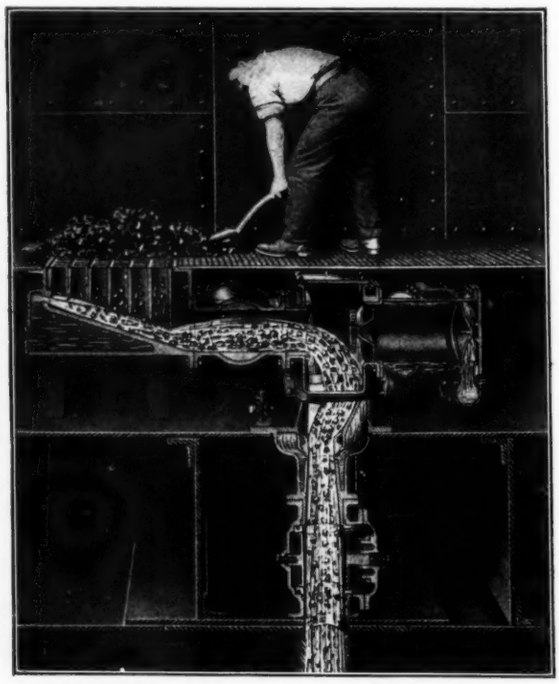


FIG. 1—STONE'S MARINE ASH EXPELLER ,OPERATED BY WATER

ship "Marlborough" was torpedoed when going into action at Jutland, and sufficient water was pumped out by these ash conveyors to enable her to continue in action throughout the battle, and to stay afloat for several days.

The rudimentary methods of removing ashes consist of hoeing them out of the firedoors and ashpits and then removing them in wheelbarrows to the dumping point. The wheelbarrows can be replaced either by mechanical or by air conveyors. A mechanical conveyor consists of a block and chain containing buckets, running in a trench under the fireroom floor, into which ashes are hoed through a grating.

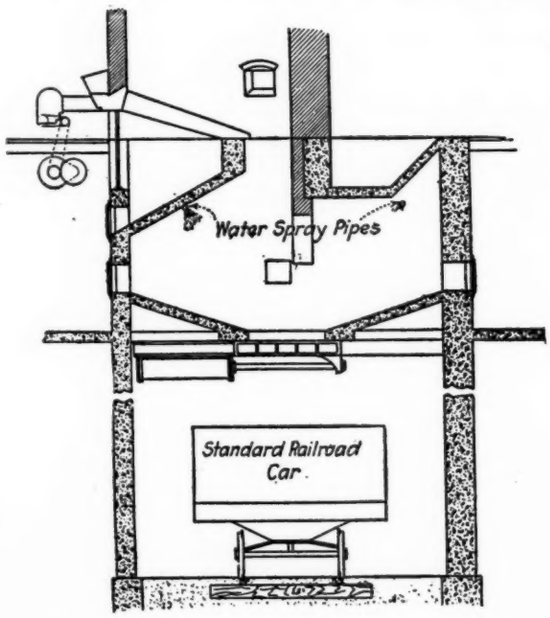


FIG. 2—LARGE-CAPACITY HOPPER ASHPIT

When a plentiful supply of water is at hand, a flume may be used under the boiler-room floor into which ashes can be hoed.

The problem is more complicated when the boiler room is considerably below the ground level. Ordinary methods consist of loading ashes into cans and then hoisting them by tackle to the surface, where they are emptied into hoppers or vehicles, which requires a high labor cost. A cheaper and more modern method is to use an air or so-called steam-jet conveyor for discharging the ashes. This is often objectionable on account of the noise and dirt. Mechanical elevators may also be used to advantage.

Hopper Ashpits

The general size and design of the hopper ashpit will depend primarily upon the manner in which the ashes flow into it, the method of removal and also the system of draft; the design begins at the top to suit the stoker. Where conveyors are installed, it is the usual practice to use a side door for the hopper and work the ashes out gradually to avoid choking, which would happen with a straight dump.

Ashes may be stored either in the ash pit or the elevated ash bin if there is one. In the latter case very little storage room is necessary in the hopper ashpit. Twenty-four hours' capacity of the pit, however, should be provided in order to take care of possible breakdowns of the conveying apparatus. With a continuous conveyor system this capacity is at a minimum.

Sufficient space should be left above the top of the ashes to prevent burning and breakage of stoker mechanisms. An allowance of forty pounds of ashes per cubic foot of storage space is good practice. Fifty per cent greater capacity than the calculations show is advisable, as other factors such as unburned coal in times of peak load or emergency conditions must be taken care of.

Water-supply pipes should be provided for quenching the ashes in case storage leaks should occur.

*Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers, Dec. 4-7, 1922. Mr. Hunter is chief engineer of the Heine Boiler Co., has had extensive marine experience and was formerly chief engineer of the Union Light & Power Co., St. Louis. Mr. Cotton is chief of the Research Department of the Heine Boiler Co. and has made extensive investigations in regard to combustion and heat transfer. He has had considerable engineering experience in England, of which both he and Mr. Hunter are natives and he developed the Cotton furnace, which embodied a high efficiency system of steam-jet forced draft.

The sides should slope at not less than 45 deg. in any case, and a minimum of 50 deg. with the horizontal is preferable. If one side is vertical, the opposite side may have the minimum slope; but where two opposite sides slope, neither should slope less than about 55 deg. If the slope is too small, arching of the ash is likely to occur, and this will increase operating costs owing to the frequent necessity of encouraging the flow by breaking away the ash with bars poked up through the discharge doors. Where the width of the hopper would necessitate too great height to get these required slopes, the ashpit may easily be divided so as to have several discharge openings.

If a very small slope is used so as to get large capacity, access doors should be provided at the top of the slope so that the ashes may be pushed to the dump doors with a minimum of labor, and ample space should be left so that long ash tools can be wielded with ease.

Large discharge openings should be used, though their size depends to some extent upon the method of firing. When small anthracite is burned with sufficient steam in the combustion air, no clinkers are formed and the ash is in small pieces and easily dumped. Modern intensive firing of bituminous coal tends to cause the formation of large clinkers, and the openings should be large enough to pass these without having to break them into smaller pieces to allow dumping. In earlier installations door openings about 18 in. square and even less were common, while modern practice required 30 to 36 in. as a minimum, with many instances of clear openings 5 ft. square.

Hopper Ashpit Construction

The pit is usually suspended from the structure at the firing floor level and usually consists of sheet steel lined with firebrick. Reinforced concrete, 6 in. thick, is often used satisfactorily.

Hopper ashpits should usually be provided with doors to retain the ash and prevent the passage of air, and to allow the ash being dumped or hoed out at intervals as desired. With natural draft, the doors need not be airtight so far as draft is concerned; but with closed ashpit, forced draft, the doors should be tight to avoid loss of air pressure and waste of blower power. Inleakage of air may reduce boiler efficiency in some cases by excess air passing the fire through the stoker ash dump; and when forced-draft stokers are heavily loaded, gas may escape through the dumping doors. Where much combustible gets into the ashpit, either through careless operation or imperfections in stoker design, leakage of air through ill-fitting dump doors often causes

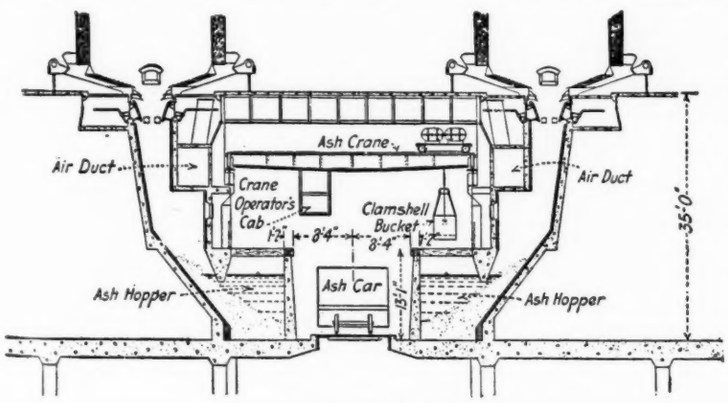


FIG. 3—WATER-SEALED ASHPIT

sufficiently rapid combustion in the ashpit to result in damage to grates, hopper structure or dumping doors. Airtight ash doors are therefore desirable in almost all cases.

There are several ways in which the dump openings may be sealed. The doors and faces may be machined, or the frame may be provided with a groove packed with asbestos rope, while the door has a rib or tongue which is squeezed into the asbestos packing by a cross-bar and screw spanning the door.

Small dumping cars drawn by horses, tractors or men, are inexpensive and in many cases very desirable. Dust is the principal objection, but there is the advantage of easily shifting the track to any point for dumping that is desired. Direct comparison between plants for this method is not especially instructive, but a few instances can be mentioned to advantage.

In one installation the hopper ashpit was arranged for dumping directly into the standard gondola railroad cars.

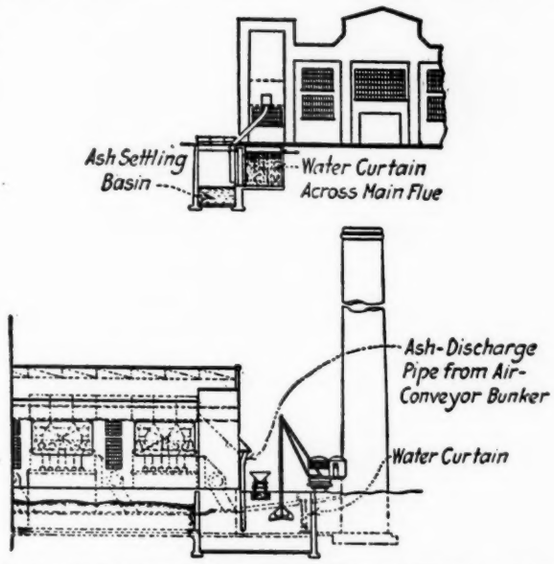


FIG. 4—AIR CONVEYOR AND SMOKE WASHER FOR PULVERIZED-COAL FIRING AT LAKESIDE STATION, MILWAUKEE

Hoppers were brick lined and had a capacity of 2,500 lb. of ashes. Ash gates were of the sliding type, operated by compressed-air cylinders, fitted with water sprays. The station consumed 413,000 tons of coal per year with 11 per cent ash and produced 13 per cent of combustible in the ash. The ashes amount to 52,800 tons yearly. It was found that 1,030 gal. of water is used in spraying one ton of ashes, which amounts to 4 per cent of the total general service water used by the station.

Owing to the abrasive nature of ash the maintenance cost of mechanical conveyors is high. The ashes grind away the connecting pins, and even with regular renewals the pins sometimes wear excessively and cause breakdowns. With a ring bucket system breakdowns are sometimes quite serious, as the ashes may have to remain in the basement for some days before the conveyor can be made to work again; and keeping the plant running under such conditions is very far from comfortable.

When handling coal and ashes in the same conveyor, there is the difficulty of the fine coal and wet ashes packing in the buckets, so that there is a needless continuous load on the equipment with a corresponding reduction in carrying capacity. The water which leaches from the ashes is exceedingly corrosive and helps to carry the fine abrasive ash into the wearing parts.

The life of these conveyors is considered to be about seven or eight years, and extensive repairs must be made every two or three years. The excessive cost of maintenance of ash conveyors of this kind has led to their replacement in some installations with electrically operated cars carrying the ashes to outside pits from which they are loaded into railroad cars with a bridge crane, and the cost of handling has been reduced by 50 per cent.

Unless the ash is sprinkled with water before it leaves the conveyor pipe, the resulting dust may be objectionable. It is usual to discharge into an elevated ash tank for convenience of railroad cars or trucks for disposal. The ash particles may attain a high velocity so that means of taking care of wear at the elbows must be considered. The speed with which ash is carried away by air conveyors is sur-

prising; it is not possible to choke an intake by as many men as can work around it. A plant containing 15 boilers of 5,000 sq.ft. heating surface, equipped with Murphy stokers, where the average ashpit contains from 1,000 to 1,300 lb., can be emptied with air conveyors manipulated by one man at the rate of eight ashpits in twenty-seven minutes.

A 6-in. conveyor has a maximum capacity of above four tons per hour; an 8-in., six to nine tons; a 9-in., ten to fifteen and possibly twenty tons. The capacity depends

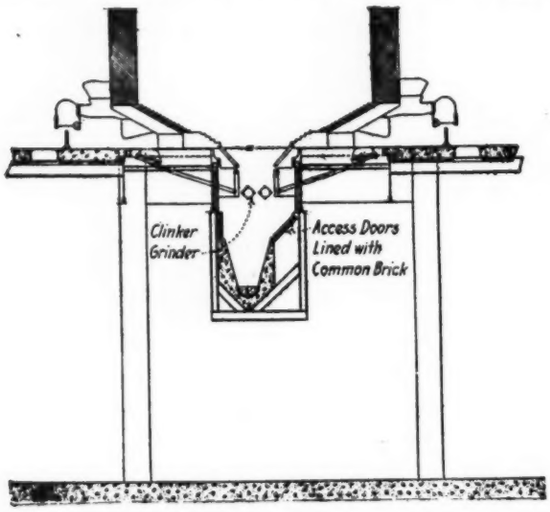


FIG. 5—WATER CONVEYOR AT HELL GATE STATION, CROSS-SECTIONAL ELEVATION

largely upon the size of the pieces. Ash should not be wet or quenched when fed to an air conveyor.

It is possible to convey horizontally about 500 ft. with a 100-ft. rise, but it is often better to connect several conveyors to a bunker rather than a branch system consisting of several conveyors emptying into one trunk line. The efficiency in the first case is better on account of less leakage through isolating dampers. This system possesses a flexibility of installation not approached by any other conveying system.

Some kind of easily replaceable target is required in or near the ash hopper, so that the ash may strike this and fall without horizontal velocity; the jet would soon wear through an ordinary tank. The cost of steam per ton of ash is quite small when properly operated. For economy the ash should be fed as fast as possible. One ton of steam will move four to eight tons of ash, depending on the length of the conveyor and the height which the ash is lifted, and the number of bends. Coal containing 12 per cent ash would require two tons of steam per 100 tons of coal. With an average evaporation of nine pounds of water the conveyor would use two tons of steam to each 900 tons generated, less than three-tenths of one per cent.

Where a natural supply of water from an elevation is not available, a centrifugal pump may be used. At Hell Gate the pump supplies water to the troughs through nozzles, pointed downstream, at each boiler. This is a system of open flumes within the boiler room continuing through a closed pipe to the ash-settling tank. Tributary flumes are carried along below each line of boilers and empty into a main cross-flume which runs along the boiler-room wall near the turbine room. This main flume then turns and becomes a full pipe or inclosed conduit leading to a pit near the river side into which it discharges.

Concrete troughs, if carefully built, will be found to require very little repair. The inside lining should be smooth and free from pits.

There should be a plentiful supply of water under a few pounds pressure. About 1,000 gal. per min. should be supplied for each flume.

With natural draft means should be devised to provide seals so as to prevent too great an excess of air from passing up through stoker dumps.

When the water is recirculated, the pump should be designed to handle gritty water, and occasional renewals due to this reason must be expected, though they will not be serious.

As there is often considerable dust and gas generated with stokers of the dumping type, it is advisable to provide the access doors with latches so that they cannot be blown open. Ample ventilation near where ashes are handled should always be provided.

While but little attention is neccessary with this method of handling ashes, it is well to have a man told off for the purpose. One man can attend and clean the circulating water screens, supervise the sluicing of ashes, and generally act as boiler-room janitor.

In some localities in winter, trouble may be expected from water freezing in the bearings of grab buckets. In particularly cold situations the wet ash will freeze in the cars and cannot be dumped unless it is thawed out. Weather conditions may therefore prohibit water conveyors in some instances.

Conclusion

Costs of equipment, maintenance or labor have not been included, although numerous cost figures have been collected, some giving very exhaustive details of cost of installation and operation. Such figures are of absolutely no value for comparison as between one station and another or as between one system and another, and are likely to do more harm than good. So many circumstances enter into any particular problem that any figures offered for comparative purposes should be used with great caution. Wide experience and sound judgment are far more valuable in this work than bald figures, and therefore no tabulation of costs of any kind has been attempted.

The primary object of any modern system of ash handling is to reduce labor costs to a minimum. Any scheme must conform to this requirement and then must conform to the further requirements of low depreciation and maintenance.

The method of ash handling adopted for any plant will be governed by the way in which the ashes are delivered from the fire and by the facilities for final disposition. It may even be the case that a system must be so devised as to meet efficiently an intended change at either or both ends.

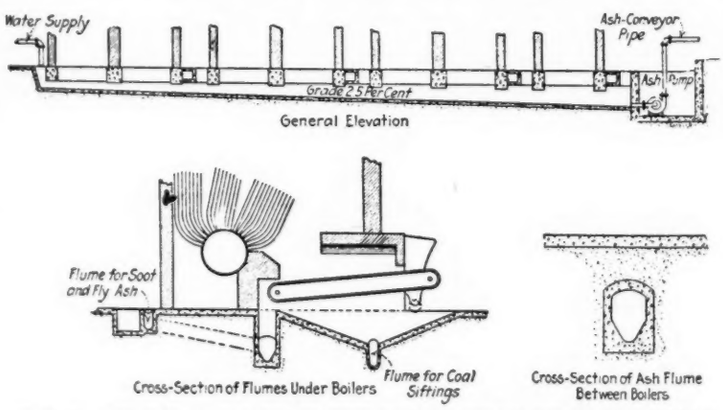


FIG. 6—MORRISON'S ASH CONVEYOR AT GREAT WESTERN SUGAR REFINERY, DENVER, PUMPS ASHES AND WATER

Reasons may exist compelling the method of firing to be changed some time after the ash-handling system has been installed, and the same thing may apply to the final disposition of the ashes. The prudent engineer will examine into future as well as present requirements.

The endeavor has been made to present sufficient description and illustration of all the successful methods of handling ash in such a manner as will enable those interested in the subject intelligently to design or criticize almost any installation with which they may be confronted.

Shale-Oil Development

A very important development to be seen on the industrial horizon is the use of oil shale as a source of supply for crude oil, gasoline, lubricating oil and ammonium sulphate. Wood long since ceased to be an economic basis for fuel; coal is now in its ascendency, but its use as raw fuel is uneconomical, wasteful, dirty, costly and unsuited to the demands of the twentieth century. The time is not far distant when the use of raw coal, as fuel, will also be abandoned. Coal will be subjected to low-temperature distillation and the products—gas, oil, and coke—will be used instead. This will conserve our natural store of fuel, save labor, remove the smoke nuisance, conserve our natural resources and meet the demands of our advancing civilization. With this economic shift from raw coal to its distillation products will come the use of oil shale, after it has yielded, by a process of destructive distillation, gasoline, lubricating oil, gas and ammonium sulphate. To one who will take a broad, comprehensive view of our economic and industrial future, it must be evident that radical changes are soon due in well nigh every phase of our fuel conditions, both as to production and use.

In a far distant geological age southern Ohio, Indiana, Illinois and Kentucky were the bed of a vast ocean, now called the Devonian Sea. In the bottom of this sea was laid down, by the erosion of the adjacent land, a vast amount of clay or shale, now known as the black shale. To this deposit fish and other forms of sea life contributed their remains in large quantities. At this stage of the earth's history land life was inconsiderable, but sea life was abundant. Consequently this particular deposit has a character all its own, as a result of containing an excess of the remains of sea life over land life. In succeeding ages layers of sandstone, limestone and other sedimentary deposits were also laid down. Finally, there came, through the general contraction of the earth's cooling surface—like the wrinkles that come on a baked apple when it is allowed to cool—a gradual elevation of these horizontal deposits into the Cincinnati uplift: that is, to the form of a flattened A.

In succeeding ages the apex of this uplift was eroded and only the sides were left sticking out. This erosion has gone so deep as to remove every stratum, in the middle of the anticlinal, down through the deposit first mentioned—that is, the Devonian—and has left the Devonian jutting out all around the outer border of the anticlinal.

In places the outcrop of shale reaches a height of 200 ft., but a conservative average for the 250 miles of exposure is 50 ft. The dip is slight so that the deposit is easily worked for an average of three miles back from the outcrop. The average of twenty samples gave 130 lb. as the weight of a cubic foot of shale. Prof. C. S. Crouse, of the University of Kentucky, who has traveled over the entire district and has made a careful, conservative survey, estimates that there are 1,000 square miles of this shale exposed and available for commercial exploitation by open-cut and steam-shovel methods. On the basis of an area of 1,000 square miles, 50 ft. thickness, and 130 lb. to the cubic foot, there is available, therefore, 90,604,800,000 tons of shale. This is a stupendous figure, but the oil-shale deposit itself is stupendous.

Professor Crouse has tested 20 samples from various sections of the state. The largest yield of oil was from the shales of Taylor County, 27.75 gal. to the ton; the lowest from Rockcastle County, 8 gal. The average oil content from these twenty samples was found to be 16.08 gal. with a possible 25 or 30 gal. a ton from over a large area of well-chosen ground. The average specific gravity was 2.173 and the average weight of a cubic foot was found to be 129.37 lb.; the sulphur ranged from 1.50 to 4.15 per cent.

Some enthusiastic persons who have seen a small laboratory retort in operation, with rock fed in at one end and oil dripping out at the other, have overworked their imagination and jumped to the conclusion that the production of shale oil would at once supplant the petroleum oil industry. Nothing could be farther from the truth. Our present domestic supply of crude oil does not equal our consumption. Imports from Mexico are needed. Salt water has entered the Mexican pools. The peak production of many of our domestic pools, Mexia, for example, has been reached. On the whole, our supply of oil from wells is uncertain. The gist of the matter is that when the total supply of oil, both domestic and Mexican, is less than the demand, a new source of supply will become imperative. The demand will place the price at a figure that will enable oil to be produced from shale at a profit. What that figure is in dollars and cents is immaterial. When that day comes, the consumer will have to pay the price or industry will cease. There will be no sudden line of demarcation between the use of well and shale oil. The change will come gradually. Rather than supplant the well oil, shale oil will merely supplement it. As the price of crude oil at the well advances, because of a lack of supply, it will approach the price at which shale oil can be produced. Then oil shale deposits, most favorably located for cheap commercial operations, will be developed and worked. Already some of the larger oil corporations, seeing the fatal day in the future, have purchased large acreages of oil-shale land, have secured United States patent, have tested with the diamond drill or surface cuts, and know exactly what they have, as a reserve and potential oil supply. When the industrial demand exceeds the supply from wells, they will be prepared to produce oil from shale.—*Colorado School of Mines Quarterly.*

Additional Bits About the Power Show

As is always the case with industrial expositions, certain of the exhibitors at the Power Show contracted for space only a few days before the opening date, so that information about their exhibits was not available until after the Dec. 12 issue of *Power* had gone to press. Among these was the Alabama Power Co., whose exhibit gave the visitor an excellent idea of the way the company is promoting industrial development in the South.

An interesting gearless transmission was found at the booth of the Driscoll Transmission Corp., of New York City, while the National Pipe Bending Co., New Haven, Conn., showed clearly the construction of its inside manifold type feed-water heater. The Protectometer Co., of Jersey City, exhibited a new instrument—the Fedco Protectometer—designed to warn against hot spots in a coal pile. Lillie evaporators were featured at the exhibit of the Sugar Apparatus Co., Pittsburgh, Pa., and at the Chapman Valve Manufacturing Co.'s booth there was found a good representation of the company's line of brass, iron and steel gate valves, the last being built to withstand 800 lb. working pressure and 800 deg. F. total temperature.

Among the exhibits devoted to the larger components of a modern power plant was that of the Allen-Sherman-Hoff Co., of Philadelphia, at whose booth was found a complete ash hopper with gate equipment, duplicating six equipments now being installed by one of the large public-service companies under 6,000-sq.ft. boilers fired by underfeed stokers. This hopper hangs from the girders and beams supporting the boiler and consists of a steel framework of vertical members attached to the beams above and the ash gate below. To the inner side of the vertical members is attached a cast-iron wall which in turn supports a tile lining.

At the exhibit of the Hagan Corp., New York City, there were shown working models of the Hagan master controller and combustion controller, and the Hagan deconcentrator for boiler-feed water was also featured.

The technical and industrial publications represented at the Show included *Combustion, Industrial Power, Industrial Management, Manufacturers Record, National Engineer, Power Plant Engineering,* Sweet's *Engineering Catalogue* and the entire line of the McGraw-Hill Co., Inc., including *Power.*

Theo. Audel Co., New York City, had on exhibit its guidebooks and handbooks for mechanical engineers.

Expenditures on the Wilson Dam will be made at the rate of $625,000 per month until September of next year, when the existing appropriation will have been exhausted. This information is contained in the annual report of the Chief of Engineers, submitted to Congress on Dec. 4.

News in the Field of Power

Harding Budget in Danger?

Congress Will Be Pressed To Cancel President's Cuts in Budget, Says John T. Pratt

DANGEROUS ATTACKS on the executive budget system, inaugurated at Washington by the Harding administration and based on the doctrine that governmental expenditures must not exceed the revenues in sight, were foreseen by John T. Pratt, financier and chairman of the National Budget Committee, in an address before the four founder engineering societies in New York City on the 13th of the present month.

The system, according to Mr. Pratt, will be in danger during the present session of Congress unless the people stand firmly behind President Harding. Jealousies, he warned, will arise in Federal bureaus and possibly in the Cabinet if pressure is brought to bear on Congress to put back all or part of some $600,000,000 that was cut from departmental budget estimates at the instance of President Harding and left out of the budget total of $3,361,000,000 recommended in the President's message to Congress. The amount allowed by the President, according to the present estimate of revenues for the coming year, would allow for a surplus of about $100,000,000, leaving out of account any extraordinary expenditures such as might be required by the adoption of the soldier's bonus, ship subsidy or other like bills.

The chairman of the National Budget Committee further stated:

"If the executive budget is to be given the force required to make it effective," Mr. Pratt said, "the President must be backed up by a united people at this juncture. The real problem before us now is whether we shall follow President Harding, in his firm insistence that the Federal Government must live within its means, or Congress, which undoubtedly will be subjected to no end of pressure from disgruntled bureau chiefs and possibly from some of the officers in President Harding's own Cabinet.

"We must strenuously object to any attempt on the part of Congress to put back any of these tentative budget items, and you should memorialize your own Representatives in Congress to that effect."

Mr. Pratt declared that the National Budget Committee would constantly try to create public consciousness in favor of preserving the integrity of the Budget Act of 1921. Other aims, he said, were reorganization on functional lines of the executive department of the government and co-ordination between the executive and the legislative branches by having Cabinet members appear on the floor of the House and Senate in defense of their Budget estimates.

Seek Economies in Operation of Government Plants

Changes in the character of coal obtainable for government power and heating plants in the District of Columbia have led to a survey of operating conditions in these plants, to be conducted by the Bureau of Mines through its division of engineering. This survey, in the form of a series of tests, is being conducted with the hope that a close study of the various government power and heating plants by experts will bring to light the possibility of various economies in fuel consumption and general operation.

The survey was inspired, it was said at the Budget Bureau, by numerous requests for funds with which to make changes in grates, necessitated by inability to secure the same character of coal formerly consumed. Some of the govenment plants in Washington have been forced to change from anthracite to bituminous coal and others which have been using Northern soft coal are now supplied with Southern fuel.

Several months will be required by the Bureau of Mines to complete this survey, and meanwhile the Budget Bureau has refused all requests for changes at government plants, except those necessitated by the replacement of worn-out material.

Does Price of Coal Include Operators' Legal Fees?

THERE is no disguising the fact that the Federal Coal Commission is not well impressed with the operators' policy of employing expensive attorneys to assist in the presentation of their cases. At a recent conference the bituminous operators' special committee had as counsel John W. Davis, former ambassador to England and solicitor-general of the Department of Justice. Were the Commission considering international matters it would be willing to admit, no doubt, that Mr. Davis could enlighten it, but the issue being considered was how best to determine the number of days an operative works in a mine. Why it should be necessary to pay an attorney a single fee of more than double the aggregate of the annual salaries of the members of the commission, when one or more of the operators' accountants could have furnished the needed information, is a matter of considerable conjecture. The question naturally has arisen as to whether or not such large legal expenses form a proper item to add to the cost of coal.

Millikan Given Edison Medal

Head of Physics At California "Tech" Honored for Electrical Research

THE Edison Medal for the year 1922 has been awarded by the Edison Medal Committee of the American Institute of Electrical Engineers to Dr. Robert A. Millkan, of Pasadena, Cal., for "his" experimental work in electrical science."

Dr. Millikan was born in Morrison, Ill., in 1868, is a graduate of Oberlin, class of 1891, and was granted a Ph.D. from Columbia in 1895. He also holds degrees from Berlin and Gottingen, Northwestern, Pennsylvania and Amherst. He took up the teaching of physics at Oberlin in 1891 and from there went to the University of Chicago where he finally became professor of physics in 1910. In 1921 he became director of the Norman Bridge Laboratory of Physics at the California Institute of Technology, where he is also chairman of the Administrative Council.

Probably the best known and most noteworthy of Dr. Millikan's works are his so-called "oil-drop" experiments, undertaken for the purpose of making precise measurements of the fundamental electrical quantity. These experiments proved conclusively that all electrons are identical and the results have been of inestimable value in the calculation of physical constants. His more recent work has tended toward a definite bridging of the gap between light and X-ray phenomena.

Although Millikan's claim to recognition rests particularly on his experimental researches, his work during the war and in the formation of the National Research Council, on which he served as executive head, is particularly noteworthy. He is the author of numerous books on physics and has contributed largely to the technical press on the same subject. He is a member of the National Academy of Sciences, American Philosophical Society, American Physical Society and the A.I.E.E.

From Private to Central-Station Power in 48 Hours

Replacing private power with central-station service in forty-eight hours was the record recently made by the Southern Colorado Power Co. at the plant of the American Beet Sugar Co. near Rocky Ford, Colo. The burning out of a 300-kw. generator in the sugar company's private power plant meant an expensive shutdown of the plant unless outside power could be obtained. Under normal conditions and working with the usual force of men, it would have required ten days to two weeks for the Southern Colorado Power Co. to extend its lines to the sugar company's plant and render service. Recognizing the

emergency, however, the power company's forces worked night and day setting poles, stringing high-tension lines from Rocky Ford to the sugar refinery, half a mile away, and installing a.c. motors in place of the existing d.c. units. In just two days from the date of breakdown the plant was again in full operation.

Oklahoma Society of Engineers Joins A. A. E.

At its annual meeting on Dec. 2 at Oklahoma City, the Oklahoma Society of Engineers voted unanimously to amalgamate with the American Association of Engineers and to form the Oklahoma division of the Association. Dan W. Patton, of Tulsa, was elected president; Max L. Cunningham, of Oklahoma City, vice-president; and E. K. Ramsey, of Oklahoma City, secretary-treasurer.

The new officers have outlined a program of state activity, including license law for engineers, amendments to the paving law and a good roads program, all of which meet with the favor of Governor-Elect J. C. Walton, a member of the Association. With a united engineering sentiment in Oklahoma the Oklahoma division, composed of chapters at Muskogee, Tulsa, Oklahoma City and the Oklahoma Society of Engineers, expects to accomplish much in the next year in the way of engineering and public interest.

Undertakes Research on Corrosion

A systematic study of practical methods for the prevention of corrosion in pipe lines, economizers, boiler tubes and hot-water supply systems is being made at the Mellon Institute of Industrial Research, University of Pittsburgh, through an industrial fellowship recently established by the National Tube Co., Pittsburgh, Pa.

Attention is being given to the classification of various waters with respect to their relative corrosive action upon iron and steel, when not exposed directly to the atmosphere. The present incumbent of the fellowship is Clifford R. Texter, who will be glad to correspond with engineers and manufacturers interested in the field to which his industrial fellowship relates.

Would Develop Newfoundland's Water Power

The government of Newfoundland is trying to interest British, American, Canadian and Newfoundland capital in a water-power development scheme. It is planned to erect pulp and paper mills, fish packing plants and saw mills, using the now wasted water powers.

The British government has been asked to finance the scheme to the extent of 50 per cent. The balance is expected to come from the United States, with J. P. Morgan & Co. as the principal investor. The investigations of American and British engineers during the coming winter will form the basis of a report on the matter.

Water-Power Projects

The revival of interest in Alaskan water-power development was evidenced by the action of the Federal Power Commission in two cases affecting that territory, while two others are pending. The Alaskan-American Paper Corp., of New York, which failed to begin work by Aug. 31, as required by its license, made satisfactory explanation and was granted two years' additional time. Approval also was given the application of Maurice D. Leehey, of Seattle, Wash., for a preliminary permit to develop power on Beaver Falls and Lake Mahoney, near Ketchikan, Alaska. A permit was granted last January but not accepted because of the low market for pulp. The applicant now has the proper financial backing, and is anxious to carry forward the development.

The Commission approved the application of the Empire District Electric Co., of Galena, Kan., for a preliminary permit to construct a power dam 175 ft. high in White River, southwestern Missouri. This dam would develop between 40,000 and 80,000 hp. and would increase the capacity of the present Forsyth project and give a regulated flow in the river for 125 miles with a fall of approximately 350 ft., almost to Batesville, Arkansas.

Favorable action toward granting a license to the Wyoming Power Co. for a constructed project on Bighorn river, near Shoahoni, Wyo., was taken by the Commission. The granting of the license had been protested by John T. Clarke, but the Commission decided that the legal rights of the protestant would not be affected by the license.

The application of the Holston River Power Co. for a preliminary permit covering the development of three power sites on the Holston River in northeast Tennessee marks the entry into the field of development of the very promising power area on the upper tributaries of the Tennessee River. Heretofore, the development of power in this region has not been attempted because of the lack of an industrial or utility load. It is believed, however, that northeastern Tennessee's power resources will be developed fairly rapidly, as has been the case during the last fifteen years with the relatively small water-powers in North Carolina and other sections of the South. The company intends to install an aggregate of 75,000 hp. at the three sites included in the project. The power resources of northeastern Tennessee are covered in the recent report made to Congress by Major H. C. Fiske, the district engineer officer with headquarters at Chattanooga.

Coming Conventions

American Association for the Advancement of Science; L. O. Howard, secretary, Smithsonian Institution, Washington, D. C. Annual meeting at Boston, Dec. 26-30.

Society of Automotive Engineers; 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 9-12.

American Engineering Council; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

Compressed Gas Manufacturers' Association; John H. Hayes, 120 W. 42d St., New York City. Annual meeting at New York City, Jan. 15.

Marine Engineers' Beneficial Association; George A. Grubb, secretary, Machinists' Bldg., 9th St. and Mount Vernon Place, Washington, D. C. Annual meeting at Washington, Jan. 15-20.

American Society of Civil Engineers, 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 17-18.

Iowa Engineering Society; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

New Publications

Clay Products Cyclopedia. Published by Industrial Publications, Inc., 407 South Dearborn St., Chicago, Ill. Cloth, 9x12 in., 200 pages text, 52 pages advertisements. First annual edition. Price, $3.

This new publication combines in one volume information which the manufacturer or user of clay products would otherwise be compelled to search for in catalogs, reference and technical books. The book consists of three main parts: a dictionary section, defining and describing 752 processes, materials and pieces of equipment; a statistics section, containing many useful tables of general engineering data, indexed for ready reference; and a catalog section, arranged alphabetically according to the manufacturer's name. The sections on refractories and fire brick contain much information on heat conductivity and tests of these materials. For a first edition the book is well gotten up and the dictionary section alone is well worth the price of the entire volume.

Personals

Charles W. Naylor, mechanical superintendent of Marshall Field & Co., Chicago, is taking a vacation trip to the Pacific Coast.

Allen J. Johnson, formerly surveyor and topographer with the Engineer Corps, U. S. Army, is now with the Atlantic City Gas Co. as mechanical engineer.

Prof. L. P. Breckenridge, of Sheffield Scientific School, Yale University, has resigned as chairman of the Fuels Divisions of the A.S.M.E. At a recent meeting of the executive committee resolutions of regret at his retirement were adopted. **David Moffat Myers** was elected to fill the consequent vacancy

upon the executive committee and Fred R. Low to the vacant chairmanship.

R. L. Beers, formerly assistant chief engineer of the Underfeed Stoker Co. of America, has been appointed chief engineer of the Detroit Stoker Co. Mr. Beers graduated from Syracuse University in 1912, and since then has been doing research work with the Bureau of Mines under O. P. Hood, special combustion work with the United States Radiator Corp., and testing with the Underfeed Stoker Co. of America.

Society Affairs

The American Society of Civil Engineers will hold its regular business meeting at 8 p.m. on Dec. 20 at the Engineering Societies' Building, New York City. E. H. Cameron will give a paper on "The Design of Structural Supports for Turbo-Generators."

Western Mass. Section, A.S.M.E., will meet on Dec. 19 at the Highland Hotel, Springfield, Mass., to hear an illustrated talk on "The Engineering Societies of South America."

Boston Society of Civil Engineers will consider "The Manufacture and Distribution of Gas" at its meeting on Dec. 20 in Lorimer Hall, Tremont Temple. There will be exhibited an operating model of a water-gas plant.

Rhode Island Section, A.S.M.E., will hear Admiral Sims on "The Relationship of the Navy and the Merchant Marine," at 8 p.m. on Dec. 19 at the Providence Engineering Society's rooms.

Liberty Association No. 15, N.A.S.E., Cincinnati, is another local that has prepared a good educational program for its weekly meetings. The list of topics for the winter months includes such subjects as the following: Unaflow engines, Corliss engines, internal combustion engines, modern methods of handling coal and ashes, modern elevators, and a description of a modern, efficient, noiseless, smokeless, clean power plant. The association meets every Saturday night at 8 p.m. at 514 Vine St., and welcomes the attendance of any brother visiting Cincinnati.

The banquet, entertainment and dance of the **Combined Associations of Greater New York, N.A.S.E.**, was held at the Hotel Commodore on Dec. 2. Over nine hundred covers were laid in the grand ball room and every seat was occupied. In all, 1,500 people were present, including many leading men in the engineering field and delegations from many engineering associations in the vicinity. A pleasing musical concert program was given during the banquet, at the close of which short addresses were made by Stephen Condon and National President Fred Felderman. An enjoyable entertainment, directed by Frank Martin, preceded the dancing. The chairmen of the various committees comprised John McGowan, William W. Downey, James D. Taylor, Wilmer Meinzer, Harry Raynor and A. S. Bennett.

Business Items

Florandin Equipment Co., 110 West 40th St., New York City, the New York representative of the Conveyors Corp. of America, Chicago, is also representing the Perfection Grate and Supply Co., Springfield, Mass., manufacturers of hand stokers and soot cleaners.

Link-Belt Co., 910 South Michigan Ave., Chicago, has promoted W. W. Sayers to the position of chief engineer of the company's Philadelphia works.

Electric Machinery Mfg. Co., Cleveland, Ohio, has appointed W. H. Feldmann, central sales manager, with headquarters in Cleveland. Mr. Feldmann has been an industrial power engineer for the last five years with the Consolidated Gas, Electric Light & Power Co., of Baltimore, and prior to that connection was with the Westinghouse Company.

Goggin & Ripley, Inc., 350 Madison Ave., New York City, a personal service corporation to assist business executives, bankers and engineers in conceiving, financing and developing construction projects, has been recently organized by Victor T. Goggin and James H. Ripley, formerly contracting engineers with Dwight P. Robinson & Co., Inc.

The Western Engineering & Manufacturing Co., 360 E. Grand Ave., Chicago, a subsidiary of the Western Valve Bag Co. has taken over the manufacture and sale of the Cleveland Clutch.

The Weston Electrical Instrument Co., Newark, N. J., announces that G. P. Atkinson, for several years connected with its home office sales organization, has opened an office in Atlanta, Ga., for the territories of Georgia, South Carolina and northern Alabama. In addition to Weston instruments, Mr. Atkinson has several other nationally recognized lines of electrical equipment.

The Goetze Gasket & Packing Co., New Brunswick, N. J., has removed its New York branch from 242 Lafayette St. to the Hudson Terminal Building, 50 Church St., where King & Shepherd, sales representatives, will have charge.

W. B. Connor, Inc., 90 West St., New York City, has transferred George Macnoe, formerly of the Boston office, to New York to take charge of the contractors sales department, handling heating and pumping equipment.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has promoted F. F. Rohrer, to the position of general contract manager. In his new position Mr. Rohrer will be a member of the staff of W. S. Rugg, general sales manager.

The Wm. T. Hand Equipment Co., 2709 Grand Central Terminal, New York City, specializing in the sale of used electrical apparatus, boilers and other power-plant equipment, was recently formed by Wm. T. Hand, formerly connected with the Technical Products, Co., Incorporated.

Trade Catalogs

Portable Loaders—Link Belt Co., 910 So. Michigan Ave., Chicago. Catalog No. 550, containing complete specifications of all the company's standard machines, including the large one-man power swiveling loader, the portable belt conveyor, the standard type "A" machine for anthracite coal, and the "CS" loader for handling sand and gravel.

Chain Grate Stokers—Laclede-Christy Clay Products Co., St. Louis, Mo. A pamphlet describing the installation of Laclede-Christy stokers in the Kansas City plant of Armour & Company, giving data on the installation and the results of tests.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 4, 1922	Dec. 11, 1922
Pool 1,	New York	$5.00–5.50	$5.00–5.50
Smokeless,	Columbus	6.00–6.35	5.75–6.25
Clearfield,	Boston	3.25–3.75	3.25–4.00
Somerset,	Boston	3.50–4.25	3.50–4.25
Kanawha,	Columbus	3.25–3.50	3.00–3.50
Hocking,	Columbus	2.75–3.25	2.50–2.75
Pittsburgh No. 8	Cleveland	3.15–3.25	3.00–3.25
Franklin, Ill.,	Chicago	4.00–4.25	4.00–4.25
Central, Ill.,	Chicago	3.00–3.25	3.00–3.25
Ind. 4th Vein,	Chicago	3.75–4.00	3.75–4.00
West Ky.,	Louisville	2.00–2.50	2.00–2.50
Big Seam,	Birmingham	2.25–2.50	2.25–2.50
S. E. Ky.,	Louisville	3.10–3.75	3.00–3.75

FUEL OIL

New York—Dec. 14, Port Arthur light oil, 22@25 deg. Baumé, 4⅛c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Dec. 1, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2⅞@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Philadelphia—Dec. 11, 26@28 deg. Baumé, Oklahoma, 90@95c. per bbl.; 30@34 deg., Oklahoma (group 3). 2⅝@2¾c. per gal.; 16@20 deg. Seaboard, $1.30@$1.40 per bbl.

St. Louis—Dec. 5, f.o.b. Oklahoma 24@26 deg., 95c. per bbl.; 26@28 deg., $1 per bbl.; 28@30 deg., $1.05 per bbl.; Gas oil 32@36 deg., 2⅞@3c. per gal.; 36@40 deg., distillate, 3½@3⅝c. per gal.

Pittsburgh—Dec. 6, f.o.b. refinery, Penn., 36@40 deg., 5½@5⅝c. per gal.; Kentucky, 26@30 deg., 4c.; Diesel, 3¼c.; Gas oil, 32@36 deg., 2½@2⅝c.; 36@38 deg., 2½@3c.; 38@40 deg., 2⅝@3¼c. per gal.; Western, 24@30 deg., 90c.@$1.05 per bbl.

Cincinnati—Nov. 27, for 26@28 deg. Baumé, 1¼c. per gal.; 28@30 deg., Diesel, 5¾c.; 38@40 deg., distillate, 6¼c. per gal.

Cleveland—Nov. 27, for 26@28 deg., Baumé, 4⅜c. per gal.

Dallas—Dec. 9, 26@30 deg., $1.25 per bbl.

New Plant Construction

PROPOSED WORK

Calif., Los Angeles—A. C. Blumenthal, et al., 105 Montgomery St., San Francisco, is having plans prepared for the construction of a 12 story, 130 x 150 ft. apartment building on Wilshire Blvd., here. Estimated cost $1,000,000. Macdonald & Couchot, 234 Pine St., San Francisco, Archts. Equipment detail not reported.

Calif., Napa—The Atlas Peak Sanitarium, Dr. C. H. Bulson, Mgr., is having plans prepared for the construction of a group of buildings for a tubercular sanitarium on a 170 acre site at Harris Ranch. Estimated cost $300,000. J. Morgan, Merchants' Exchange Bldg., San Francisco, Archt. Equipment detail not reported.

Calif., San Francisco—The ctiy and county of San Francisco plans the construction of a new Mission High School, about $1,000,000; also 16 classroom annex to Portola School, 10 classroom addition to North Beach Primary School and auditorium and annex to the High School of Commerce. J. Reid, Jr., 1st Natl. Bank Bldg., City Archt.

Calif., Santa Barbara—The state plans additions to the State College buildings, here, including administration building, training school and auditorium. Estimated cost $585,000. B. G. McDougall, Forum Bldg., Sacramento, State Archt. Equipment detail not reported.

Fla., St. Petersburg—S. Lund, Huntington Hotel, plans the construction of a 250 room hotel. Estimated cost $1,000,000. Architect not selected.

Ill., Chicago—Dr. S. M. Edison, c/o D. A. Klafter, Archt., 64 West Randolph St., is having plans prepared for the construction of a 10 story, 108 x 125 ft. hotel, including steam heating system on Cornelia St. Estimated cost $1,250,000.

Ill., Chicago—A. S. Hecht, Archt., 155 North Clark St., is receiving bids for the construction of a 7 story, 53 x 108 ft. hotel, including steam heating system, on Buena Park and Hazel Sts., for the Buena Park Hotel Corp. Estimated cost $380,000.

Ill., Chicago—The E. L. Mansure Co., 16th St. and Indiana Ave., plans the construction of an 8 story, 175 x 530 ft. office and factory building, including steam heating system. Estimated cost $1,750,000. Architect's name withheld.

Ill., Chicago—Schmidt, Garden & Martin, Archts., 104 South Michigan St., plans the construction of a 375 x 465 ft. hotel, including steam heating system, on 55th St. and South Shore Drive. Estimated cost $5,000,000. Owner's name withheld.

Ill., Shelbyville—The city will take bids about Dec. 18th for the construction of an electric light plant and distribution system. Estimated cost $100,000. Noted Nov. 28.

Ind., Fort Wayne—The Masonic Temple Building Co. plans the construction of a 5 story 90 x 130 ft. temple. Estimated cost $1,000,000. C. R. Weatherhogg, Citizens Trust Bldg., Archt. C. C. French, Plymouth Bldg., Cleveland, O., Consult. Engr.

Ind., Hammond—The Hammond Hotel & Improvement Corp., c/o Crane & Franzheim, Archts., 127 North Dearborn St., Chicago, is having plans prepared for the construction of a 4 story hotel, including steam heating system here. Estimated cost $500,000.

Ia., Sioux City—The Methodist Hospital, 14th and Jones Sts., plans the construction of a 4 story hospital. Estimated cost $300,000. Beuttler & Arnold, 406 Grain Exchange Bldg., Archts.

Kan., Wichita—The Alpine Ice Co., C. M. Beachy, Purch. Agt., 13th Ave. and Rock Island St., is in the market for a 90 ton ice machine, belting, pulleys, hangers, motor, engine and steam boilers.

Kan., Wichita—The Garden City Feeder Co., 120 South Wichita St., is in the market for 110 volt single phase motor.

Ky., Louisville—The Bd. Educ. plans the construction of a 1 story, 200 x 225 ft. school, including heating and ventilating system, straight blast ventilated type with thermostatic regulators, medium pressure boilers and steam driven fans, on Virginia Ave. E. A. Rassinier, 2217 Blvd. Napoleon, Engr.

La., Baton Rouge—The Greater Agricultural College, Bldg. Com., will soon award contracts for the construction of a power house and engineering shops. Estimated cost $130,000. R. L. Hines, Purch. Agt., State University.

Mass., Cambridge—The Ford Motor Co., Highland Park, Detroit, Mich., is having preliminary sketches prepared for a 3 story, assembly plant and power house, here. Estimated cost $300,000. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt. and Engr.

Mich., Ecorse—The Michigan Steel Corp., 1708 First Natl. Bldg., plans the construction of a steel plant consisting of six mills for manufacture of sheet steel on the Rouge River. Estimated cost $1,000,000. Private plans. Heavy rolling mills and equipment also traveling cranes and electrical power equipment will be installed.

Mich., Flint—The Bd. Educ. plans the construction of 2 high schools, including steam heating equipment. Estimated cost $750,000 each. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Detroit, Archts.

Mich., St. Joseph — Cahill & Douglas, Engrs., 217 Water St., Milwaukee, Wis., will receive bids in March, 1923, for the construction of a 2 story, 100 x 132 ft. power house and store house, radial stack 125 ft. high, 3 boilers and electric generating unit for the Whitcomb Hotel here. Estimated cost $50,000. Engineer is now receiving bids on a 7 ton ice machine.

Miss., Corinth—The city, M. T. Sharp, Clk., will receive bids until Dec. 21 for waterworks improvements, including filter plant, settling basin, distribution system, also 1 deep well pump, two 250 g.p.m. motor driven pumps, one 250 g.p.m. wash pump, two 400 g.p.m. low pressure, one 600 g.p.m. spray pond equipment. Noted Nov. 7.

Miss., Jackson—The Edwards Hotel, J. L. Ware, Prop., will receive bids about Feb. 1, 1923, for the construction of a 10 story, 132 x 140 ft. hotel and power plant, including heating, lighting and refrigerating systems on Capital St. Estimated cost $1,000,000. W. T. Nolen, New Orleans, La., Archt.

Mo., Bolivar — Alexander & Baity, 535 West Commercial St., Springfield, will receive bids after Dec. 15 for an electric light and power plant. Estimated cost $32,000. Private plans.

Mo., Paris—The city will soon receive bids for equipment for 10 ton ice plant. W. B. Rollins & Co., 521 Railway Exchange Bldg., Kansas City, Engrs. Noted Nov. 14.

Mo., Rich Hill—The city will soon award the contract for the construction of a power house, furnishing and installing machinery and equipment for same. A. L. Mullergren, 555 Gates Bldg., Kansas City, Consult. Engr. Noted Nov. 14.

Mo., St. Louis—The city plans election Feb. 9, 1923, to vote $88,752,500 bond issue for improvements, the following are included in the list: Proposition 4, purchase and installation of equipment for an electric street lighting system, $8,000,000; proposition 11, erection of a combined plant and the installation therein of equipment to provide light, heat and power to municipal buildings, also machine shop, garage and laundry for municipal requirements, $1,000,000; proposition 12, acquisition of land and the construction of additions to and extensions and equipment of public hospitals and institutions, $4,500,000; proposition 21, for waterworks improvements including new plant on Missouri River, equipment, such as generators, service pumps, etc., reservoir, mains, contingencies, etc., $12,000,000.

Mo., St. Louis—The Hotel Jefferson Co., 12th and Locust Sts., will soon receive bids for the construction of a 13 story, 220 x 275 ft. addition to hotel, on Locust and 13th Sts. Estimated cost $2,500,000. T. P. Barnett, Arcade Bldg., Archt. Equipment detail not reported.

N. H., Bristol—The Utilities Power Co., Meredith, is having plans prepared for the construction of a hydroelectric plant and 55 x 1,000 ft. dam on the Pemigewasset River, Ayres Island. Estimated cost $600,000. Jackson & Moreland, 387 Washington St., Boston, Mass., Archts. and Engrs. Noted Oct. 3.

N. J., Atlantic—L. R. Pollock, 30 South Pennsylvania Ave., plans the construction of a 4 story, 90 x 155 ft. addition to hotel. Estimated cost $500,000. F. A. Berry, Real Estate Trust Bldg., Phila., Pa., Archt.

N. Y., Alexandria Bay—R. Hood, Archt., 7 East 42nd St., New York, is preparing plans for the construction of a 300 room hotel, here. Estimated cost $800,000. Owners' name withheld.

N. Y., East Rochester—J. Bishop, 218½ West Elm St., is in the market for horizontal steam engine with boiler.

N. Y., Mechanicsville—Geo. P. Ide Co., 521 River St., Troy, is in the market for complete equipment for power house to be constructed in connection with new 2 story addition to plant, here.

N. Y., New York—The 5th Ave. and 10th St. Corp. c/o Schwartz & Gross, Archts., 347 5th Ave., will soon receive bids for the construction of a 14 story, 95 x 150 ft. apartment building. Estimated cost $1,500,000. Equipment detail not reported.

N. Y., New York—N. J. Hayes, Comr. Water Supply Gas & Electricity, 2351 Municipal Bldg., Manhattan, will receive bids until Dec. 22 for furnishing, delivering, installing and connecting forged steel crossheads one each on the high, intermediate and low pressure cylinders of Davis & Farnum engines in the Ridgewood Northside Pumping Station, Atlantic Ave. and Logan St., Brooklyn.

N. Y., New York—Wm. H. Rahman & Son, Archt., 126 Cedar St., is having plans prepared for the construction of a 3 story, 150 x 150 ft. theatre on East Fordham Rd. Estimated cost $500,000. Equipment detail not reported. Owner's name withheld.

N. C., Brickhaven (Raleigh P. O.)—The Carolina Power & Light Co., P. A. Tillery, Mgr., Raleigh, plans the construction of a 15,000 kw, steam plant, ultimate capacity 60,000 kw., including equipment, on the Cape Fear River, 35 mi. from here. Project will be used for supplementing the company's hydro-electric plants in times of low water.

N. C., Davidson—The city, W. H. Thompson, Clk., plans the construction of a reservoir and steel tank, also pumping equipment. Estimated cost $60,000. Mees & Mees, Kinney Bldg., Charlotte, Engrs.

N. C., Gold Hill—The Rodrain Electro-Metallurgical Co., plans the construction of a complete gold mining plant. Estimated cost $500,000. Engineer not announced. Owner is in the market for machinery and equipment, including conveyors, transmission machinery, etc.

Ohio, Cleveland—The Bd. Educ., F. G. Hogen, Dir., East 6th St. and Rockwell Ave., received bids for the construction of a 3 story, Junior High School on West 46th St. and Hyde Ave., from J. F. Hohlock, Davis & Farley Bldg., $619,983; Philipp Kirschner & Co., 1104 Prospect Ave., $650,000; heating and ventilating, Becker Seidel Co., 324 Prospect St., $89,990. W. R. McCornack, East 6th St. and Rockwell Ave., Archt. Noted Nov. 21, 1921.

Ohio, Cleveland—The Bd. Educ., F. G. Hogen, Dir., plans the construction of a 3 story, 45 room Junior High school, including steam heating system, in Nottingham Dist. Estimated cost $1,000,000. W. R. McCornack, East 6th St. and Rockwell Ave., Archt.

Ohio, Cleveland—R. S. Harsh, Archt., Hartman Bldg., Columbus, will receive bids until Jan. 3, 1923, for the construction of a 1 story, 180 x 180 ft. hospital, here, for the Dept. of Welfare, 9th and Oak Sts., Columbus. Estimated cost $275,000. Equipment detail not reported.

Ohio, Delaware—The Dept. Pub. Service, W. H. Duffy, Dir., City Hall, Columbus, will receive bids until Jan. 4, 1923, for 60 x 80 ft. power house, laundry, small pumping station, 15,000 coagulating and 26,000 gal. reserve reservoir, for the Girls Industrial Home, here.

Ohio, Toledo—The Home Savings Bank, Gardner Bldg., c/o M. Miller, Pres., is having sketches prepared for the construction of a 10 story bank and office building on Huron and Madison Sts. Estimated cost $1,000,000. Walker & Weeks, 1900 Euclid Ave., Cleveland, Archts.

Okla., Ada—The Oklahoma Portland Cement Co., is in the market for complete electric power house equipment for plant in connection with factory.

Okla., Cyril—The city will receive bids until Jan. 15, 1923, for elevated tank, 1 mi. 6 in. pipe, 2 mi. 4 in. pipe and deep well pump; $31,000 bonds have been voted for same. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs.

Ore., Flora—The Flora Logging Co., c/o J. C. Veazie, Corbett Bldg., Portland, plans the construction of a sawmill here. Estimated cost $50,000. Owner is in the market for boiler, engine, skidding engines, cables, etc.

Pa., Abington—Tilden & Register, Archts., 1525 Locust St., Phila., are receiving bids for the construction of a 2 story, 29 x 66 ft. heating plant and laundry for the Abington Memorial Hospital, here. Estimated cost $75,000.

Pa., Blossburg—The Blossburg Elec. Light & Power Co. plans the construction of a new light and power plant in South Blossburg. Estimated cost $1,000,000. Owner is in the market for equipment.

Pa., Galeton—The Galeton Electric Co., plans improvements to its lines and works. Estimated cost $60,000.

Pa., Huntingdon — The Cover Electric Co. plans to issue $25,000 bonds for improvements and extensions to plant and service.

Pa., York—The city council, A. Bowman, Mayor, plan to vote $300,000 bonds for the construction of an electric light plant.

Tenn., Memphis—The Columbian Mutual Life, Odd Fellows Bldg., will soon receive bids for the construction of a 22 story, 75 x 77 ft. office building on North Court and Main Sts. Plans include 3 boilers, of 15,000 ft. of radiation each for vapor heating system, airwasher and fans to provide 30,000 cu.ft. of air per min., circulating ice water system, 2 ton capacity, etc., 2,500 gal. per hr. pumping capacity. Estimated cost $1,000,000. Boyer & Baum, 428 Arcade Bldg., St. Louis, Mo., Archts. and Engrs.

Tex., Austin—The Baker Hotel Co., San Antonio, is having plans prepared for the construction of an 11 story, 65 x 90 ft. hotel. Estimated cost $400,000. Sanguinet, Staats & Hedrick, 1st Natl. Bank Bldg., Ft. Worth, Archts. Equipment detail not reported.

Tex., Houston — The Houston Light & Power Co., C. Bertran, Mgr., plans the construction of a 20,000 kw. power plant. Estimated cost $1,000,000.

Wash., Inchelium—The Inchelium Water Power Co., F. M. Mitchell, Pres., plans the construction of a hydro-electric power plant; owner has been granted a permit to build a dam and divert water from Stranger Creek.

Wash., Kelso—The Long Bell Lumber Co., Long Bldg., Kansas City, Mo., is receiving bids for the construction of a 6 story, 82 x 134 ft. hotel at Industrial City near here. Estimated cost $400,000. F. E. McIlvain, 1001 Orear-Leslie Bldg., Kansas City, Mo., Archt. Equipment detail not reported.

Wash., Seattle—The Bd. Pub. Wks., C. B. Bagley, Secy., Rm. 234 County-City Bldg., received bids for complete erection of West Spokane Street Bridge across the West Waterway at Spokane St., from Jahn & Bressi, Thompson Bldg., Strauss design, $444,923, City design, $460,700; combination bids submitted by 3 contractors as follows: Furnishing and delivering steel at bridge site, Bethlehem Shipbuilding Corp., Ltd., Morris Bldg., Phila., Pa., $260,863; erecting steel from Gerrick & Gerrick Co., Central Bldg., $105,400; electrical equipment, Butte Electric & Mfg. Co., 534 Folsom St., San Francisco, Calif., $24,422. Noted Nov. 21.

Wash., Tacoma—The director of the U. S. Veterans' Bureau, Office of Quartermaster General, 2306 Munitions Bldg., Wash., D. C., will receive bids until Jan. 16 for the construction of a neuro-psychiatric hospital at American Lake, including 28 buildings complete with water, lighting, heating and sewer systems, etc., for the Veterans' Bureau.

Wash., Vancouver—The Western Lumber & Door Co., Vancouver, U. McDonald, Supt., 315 Failing Bldg., Portland, Ore., is in the market for a complete line of sash and door machinery, also 60 hp. engine and 100 hp. boiler for $50,000 planing mill now under construction, here.

W. Va., Fairmont — The Imperial Ice Cream Co., G. Strong, Pres., is in the market for ice and refrigeration machinery.

W. Va., Logan—The Kentucky & West Virginia Coal Co. plans to rebuild power plant recently destroyed by fire. Estimated cost $30,000. Prices wanted on equipment.

W. Va., Morgantown—The Morgantown Hotel Co., J. H. Poling, Pres., plans the construction of a hotel on High and Chestnut Sts. Estimated cost $500,000. Architect not selected.

W. Va., Wheeling—The city, C. H. Dowler, Mgr., will receive bids until Dec. 21 (change of date) for pumpage and power machinery for new waterworks plant. Noted Nov. 21.

Wis., Madison—The Hotel Wisconsin Co., c/o W. Schroeder, 86 Michigan St., Milwaukee, plans the construction of a 9 story, 80 x 160 ft. hotel, here. Estimated cost $1,000,000. M. Tullgren & Sons Co., 425 East Water St., Milwaukee, Archts.

Wis., Milwaukee—A. Bergenthal, 83 Buffalo St., is in the market for power driven refrigeration machinery.

Wis., Milwaukee—The Creamery Package Mfg. Co., 61 West Kinzie Ave., Chicago, Ill., is having plans prepared for the construction of a 3 story, 165 x 266 ft. administration building and warehouse, on West Division St., here. Estimated cost $500,000. M. Tullgrens Sons Co., 425 East Water St., Archts. Equipment detail not reported.

Wis., Sturgeon Bay—Door County Growers' Union, E. L. Johnson, Mgr., plans the construction of a 2 story cold storage plant, and a dehydrating plant. Estimated cost $50,000. Architect not selected.

B. C., Esquimalt—The Dept. Pub. Works, R. C. Desrochers, Secy., Ottawa, Ont., will receive bids until Jan. 31, 1923 (change of date) for the construction and installation of pumping and other machinery for the Dry Dock, here. Estimated cost $50,000. Noted Dec. 12.

Ont., North Bay—The town council, J. Ferguson, Mayor, Town Hall, plans the installation of a hydro-electric power plant on the French River at Chandiere Falls to relieve power shortage here and in neighboring towns. Project would consist of 3 plants developing a total of about 30,000 hp. and a 35 mi. transmission line. Estimated cost $3,000,000.

Ont., Port Arthur—The N. Bawlf Co., N. Bawlf, Pres., Winnipeg, Man., will receive bids until Dec. 30, for the construction of a 200 x 250 ft. grain elevator, 80 ft. high, capacity 1,500,000 bu., including steam heating system, electrical equipment and elevator machinery. Estimated cost $800,000. C. D. Howe Co., Archts. and Engrs.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.
Everything possible is done to insure authenticity and timeliness.
Your co-operation is invited in helping us maintain this service at the highest efficiency.

BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

Ont., Timmins—The Hollinger Consolidated Gold Mines, Ltd., plans the construction of a hydro-electric plant on the Abitibi River at Island Portage, including dam, power house, installation of equipment including three 10,000 hp. turbo generators, transformers, oil switches, lightning arresters cranes, sluices, exciters, pumps, etc., and 75 to 80 mi. high voltage transmission line, from Island Portage to here, estimated cost $3,000,000; also contemplate doubling capacity of mine, which will entail machinery for handling another 4,500 ton of ore per day, crushers, drills, conveying equipment, stamp mills, amalgamators, etc.

Ont., Toronto—The Hospital for Incurables, A. Kent, Pres., Dunn Ave., plans the construction of a 3 story addition to hospital, including steam heating system, etc. Estimated cost $250,000. Architect not selected.

Que., Montreal — The Dominion Square Realty Co., D. B. Munger, Pres., plans the construction of a 10 story, 113 x 170 ft. store and office building on St. Catherine and Peel Sts. Estimated cost $3,250,000. Ross & McDonald, Belmont St., Archts.

CONTRACTS AWARDED

Ala., Montgomery—The Atlantic Ice & Coal Co., Perry St., awarded the contract for the construction of a 150 ton ice plant, 4,000 ton ice storage and 100,000 cu.ft. cold storage, to C. A. D. Bayley, 16 East 15th St., Atlanta, Ga., $300,000.

Calif., Redwood City—The Sequoia Union High School Dist. awarded the contracts for the construction of a high school as follows: general to R. Trost, 26th and Howard Sts., San Francisco, $210,704; heating and ventilating, J. F. McGowan, 180 Jessie St., San Francisco, $33,997. Noted Dec. 7.

Conn., Stamford—The Stamford Gas & Electric Co., 11 Bank St., awarded contract for foundation for large turbine and a tunnel, at its plant, to the T. J. Pardy Constr. Co., 1387 Seaview Ave., Bridgeport. Estimated cost $30,000.

Del., Clayton—J. A. Spahne Co., 111 West 8th St., Wilmington, awarded the contract for the construction of a 75 x 100 ft. ice manufacturing plant here, to J. A. Bader & Co., 923 Market St., Wilmington. Estimated cost $30,000. Refrigerating machinery will be installed.

Ia., Cedar Rapids—The Mercy Hospital Assn., c/o Sister Cephaes, awarded the general contract for a 4 story hospital addition and remodeling present buildings, on 6th Ave., to Lightner Bros., Cranby Bldg., about $250,000. Steam heating system will be installed.

La., Westwego—The Philip W. Babcock Interests awarded the contract for installing a steam power plant, pumping and cooperage equipment at the transit petroleum plant, to the Standard Equipment Co., 622 Tchoupitoulas St., New Orleans, $125,000.

Me., Windham (Windham Center P. O.)—The Mallison Falls Power Co., Westbrook, awarded the contract for the construction of a 1,000 kw. power plant, here, to the H. P. Cummings Constr. Co., Fidelity Bldg., Portland. Estimated cost $100,000.

Minn., Northfield—St. Olaf's College, P. O. Holland, Bus. Mgr., awarded the general contract for the construction of a 71 x 88 ft. power house and heating plant, to J. F. Kump, about $50,000. Noted Dec. 12.

Miss., Bay St. Louis—The Bd. of Aldermen and R. W. Webb, Mayor, awarded contracts for waterworks system as follows: reservoir and pumphouse and hauling and installing pumps, to Chambers & Bowers, Hammond, La., about $4,500; steel tower and tank, Pitts Des Moines Steel Co., Dallas, Tex., $5,540; three motor driven fire pumps, Southern Jobbers' Suppply Co., 515 South Peters St., New Orleans, La., $3,880; pipe and specials, pipe fittings, National Cast Iron Pipe Co., Birmingham, Ala., $26,462. Noted Nov. 7 under Louise, Miss.

Mo., Kansas City—The Hall Bros. Co., 1114 Grand Ave., awarded the contract for the construction of a 5 story, 100 x 115 ft. building for the manufacture of stationery, etc., on 26th and Walnut Sts., to Frank Hill Smith, Inc., Winters Bldg., Dayton, O., $1,250,000. Equipment detail not reported.

N. Y., New York—The 1101 Park Ave. Corp., c/o L. Candella, Archt., 200 West 72nd St., will build a 14 story, 100 x 125 ft. apartment building, by separate contracts under supervision of the architect, on Park Ave. Estimated cost $1,500,000. Equipment detail not reported.

N. C., Kings Mountain—The city awarded the contract for improvements to waterworks and sewerage system, including 500,000 gal. reservoir, new pumping station, sewerage sedimentation tank, also 2 mi. 6 to 14 in. water mains and 2 mi. of sewer line, to Guion & Withers, Gastonia, $59,769. Noted Nov. 21.

Ohio, Cleveland—The city awarded the contracts for the construction of a 30 x 35 ft. pumphouse and substructure at the Lake Shore Blvd., pumping plant, to the Western Reserve Constr. Co., 2244 Murray Hill Rd., $19,736. Noted Dec. 12.

Ohio, Columbus—The Neil House Co., awarded general contract for the construction of a 12 story, 187½ ft. x 187½ ft. hotel, on South High St., to the Boyle-Robertson Constr. Co., Evans Bldg., Wash., D. C., about $3,500,000. Vapor heating system, refrigerating plant, laundry equipment, etc., will be installed.

Pa., Phila.—The Jefferson Hospital, 12th and Sansom Sts. awarded the contract for the construction of a 14 story, 90 x 115 ft. hospital annex to Wark & Co., 231 South Broad St., $1,400,000. Indirect heating and ventilating system will be installed.

Tex., Dallas—The Dallas Power & Light Co., Interurban Bldg., awarded the contract for the construction of a 15,000 kw. power plant on Flynn St., also power lines, to the Texas Constr. Co., Interurban Bldg. Estimated cost $2,800,000. Noted Oct. 31.

Wis., Menasha—The John Strange Paper Pail Co., J. Strange, Pres., will build by day labor a 3 story, 60 x 100 ft. pail factory. Estimated cost $50,000. Sprinklers and several 1,000 hp. boilers will be installed.